2230A

LEVEL GENERATOR
FREQUENCY SYNTHESIZER
50Hz_1MHz

instruction manual

adret
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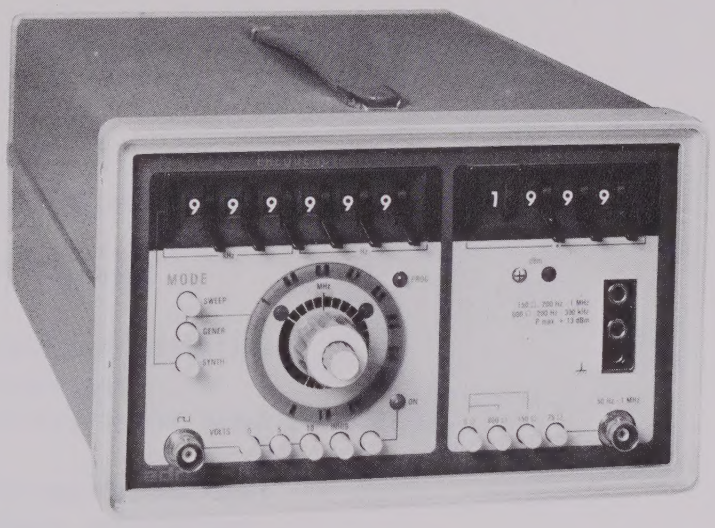
electronique®



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SUMMARY

CHAPTER I	FUNCTIONAL DESCRIPTION	
CHAPTER II	SPECIFICATIONS	
CHAPTER III	PRINCIPLE OF OPERATION	
III-1	INTRODUCTION	III-1
III-2	PRINCIPLE OF THE 2230A SYNTHESIZER	III-2
CHAPTER IV	OPERATING INSTRUCTIONS	
IV-1	CONTROLS DESCRIPTION	IV-1
IV-2	INSTALLATION	IV-1
IV-3	OUTPUT FREQUENCY	IV-1
IV-3-1	Synthesizer mode	IV-1
IV-3-2	Generator mode	IV-1
IV-3-3	Sweeper mode	IV-3
IV-4	MAIN OUTPUT	IV-3
IV-4-1	75 Ω impedance	IV-3
IV-4-2	150 Ω impedance	IV-4
IV-4-3	600 Ω impedance	IV-4
IV-4-4	0 Ω/150 Ω impedance	IV-4
IV-4-5	0 Ω/600 Ω impedance	IV-4
IV-5	SQUARE WAVE OUTPUT	IV-4
IV-6	TRACKING OUTPUT	IV-4
IV-7	Z < 1 Ω AUXILIARY OUTPUT	IV-5
IV-8	ALC TIME CONSTANT	IV-6
IV-9	OUTPUT LEVEL INHIBITION	IV-6
IV-10	REFERENCE FREQUENCY	IV-6
IV-11	SUPPLY VOLTAGES OUTPUT	IV-6
IV-12	PARALLEL BCD PROGRAMMING (OPTION 010)	IV-7
IV-13	IEEE BUS PROGRAMMING (OPTION 020)	IV-8
IV-13-1	Addressing	IV-8
IV-13-2	Frequency programming	IV-9
IV-13-3	ALC time constant programming	IV-9
IV-13-4	Output level programming	IV-9
IV-13-5	Inhibition programming	IV-9
IV-13-6	Data enable	IV-9
IV-13-7	Programming examples	IV-10
IV-14	ADAPTATION TO 19" RACK	IV-11
APPENDIX	CHART OF ASCII CHARACTERS	
	IEEE BUS PROGRAMMING WITH CALCULATOR HP 9825A	

SUMMARY

CHAPTER V		CIRCUIT DESCRIPTION	
	V-1	INTRODUCTION	V-1
	V-2	GENERATION 10^0 Hz - 10^1 Hz - 10^2 Hz	V-1
	V-3	GENERATION 10^3 Hz - 10^4 Hz - 10^5 Hz	V-5
	V-4	DEMODULATOR-AMPLIFIER	V-9
	V-5	OUTPUT LEVEL CODING	V-10
	V-6	OUTPUT MODULE	V-12
	V-7	Z < 1 Ω AMPLIFIER	V-13
	V-8	PARALLEL BCD PROGRAMMING (OPTION 010)	V-13
	V-9	IEEE BUS PROGRAMMING (OPTION 020)	V-13
	V-9-1	IEEE bus isolator	V-14
	V-9-2	IEEE bus registers	V-14
CHAPTER VI		MAINTENANCE	
CHAPTER VII		PLATES, SCHEMATICS, PARTS LIST	

LIST OF PLATES

III-1	PRINCIPE OF OPERATION
IV-1	FRONT-PANEL DESCRIPTION
IV-2	REAR-PANEL DESCRIPTION
IV-3	INTERNAL DESCRIPTION
V-1	BLOCK DIAGRAM
V-2	GENERATION 10^0 Hz - 10^1 Hz - 10^2 Hz
V-3	GENERATION 10^3 Hz - 10^4 Hz - 10^5 Hz
V-4	DEMODULATOR-AMPLIFIER
V-5	OUTPUT LEVEL CODING
V-6	OUTPUT MODULE
V-7	CONTROL CIRCUITS
V-8	POWER SUPPLY
V-9	$Z < 1\ \Omega$ AMPLIFIER
V-10	IEEE BUS ISOLATOR
V-11	IEEE BUS REGISTERS
V-12	PARALLEL BCD PROGRAMMING

CHAPTER I

FUNCTIONAL DESCRIPTION

I FUNCTIONAL DESCRIPTION

The model 2230A is a programmable frequency and level generator which covers the 50 Hz to 1 MHz range with 1 Hz resolution.

The output frequency can be controlled according to four operating modes : digital setting by six lever/indicator switches, remote programming in parallel BCD code or through the IEEE bus, analogical setting by two verniers with graduated scale, frequency sweep by external signal.

Four output signals are simultaneously available :

- A main output with pushbutton selectable impedance : 75 Ω coaxial, 150 Ω balanced, 600 Ω balanced, or low-impedance balanced (key 0 Ω).
- An auxiliary output with Z < 1 Ω impedance.
- A square-wave output with 5 V or 10 V amplitude.
- A tracking output delivering a signal with 4 MHz offset with respect to the dialled or programmed frequency.

The output level of the main signal ranges from + 19.99 dBm to - 69.99 dBm for the 75 Ω impedance, and from + 13 dBm to - 69.99 dBm for the impedances with balanced output. The level setting is directly displayed in dBm into the selected impedance (75 Ω, 150 Ω or 600 Ω). Besides, an Inhibition key permits to suppress the output signal without switching off the instrument.

The frequency and level remote programming is achieved either in parallel BCD code (option 010), or through the IEEE bus (option 020). Besides, the output level regulation may be performed with two distinct time constants, which allows to reduce the level settling time to less than 10 ms for frequencies above 10 kHz.

CHAPTER II

SPECIFICATIONS

II SPECIFICATIONS

FREQUENCY

Main output :

- 75 Ω impedance : 50 Hz* to 1 MHz
- 150 Ω impedance : 200 Hz to 1 MHz
- 600 Ω impedance : 200 Hz to 300 kHz
- 0 Ω/150 Ω impedance : 200 Hz to 1 MHz
- 0 Ω/600 Ω impedance : 200 Hz to 300 kHz

Tracking output with 4 MHz offset : 4 MHz to 5 MHz

Square wave output : 50 Hz* to 1 MHz

Auxiliary output : 50 Hz* to 1 MHz

Resolution : 1 Hz

Selection : 6 lever/indicator switches

Stability : $\pm$ 3.10^{-6}/24 h, from / 10°C to + 40°C.

* *This instrument can be used down to 10 Hz on the 75 Ω, square-wave and auxiliary outputs with some restrictions in the specifications.*

EXTERNAL REFERENCE

Substitution of the external reference for the built-in Master Oscillator.

Frequency : 5 MHz

Level : 220 mVrms to 1 Vrms/50 Ω

REFERENCE OUTPUT

Frequency : 1 MHz

Level : approximately 500 mVrms/50 Ω

FREQUENCY CONTINUOUS ADJUSTMENT

Frequency range : as for digital setting.

Frequency adjustment : by two verniers with graduated scale and by switches controlling the 1 Hz, 10 Hz and 100 Hz increments.

Dial accuracy : $\pm$ 5 % of full scale.

In this operating mode, the output frequency can be compared to the digital setting of the switches controlling the 1 kHz, 10 kHz and 100 kHz increments, thanks to a frequency comparator with LED display.

FREQUENCY SWEEP

Frequency range : same as for digital setting.

Sweep : By ± 5 V external signal.

- Input impedance : 100 kΩ
- Sensitivity : 10 mVpeak for 1 kHz deviation
- Linearity : ± 10 %
- Bandwidth :

  DC to 500 Hz for ± 5 kHz deviation
  DC to 50 Hz for ± 50 kHz deviation
  DC to 5 Hz for ± 500 kHz deviation

In this operating mode, the center frequency around which the sweep is performed depends on the two verniers with graduated scale, as also on the switches controlling the 1 Hz, 10 Hz and 100 Hz increments.

Besides, the output frequency can be compared to the digital setting of the switches controlling the 1 kHz, 10 kHz and 100 kHz increments, thanks to a frequency comparator with LED display.

OUTPUT LEVEL

Several signals are simultaneously available :

- The main signal, delivered on the front panel with 0 Ω, 75 Ω, 150 Ω or 600 Ω impedance selected by pushbutton.
- A square-wave output, delivered on the front panel.
- A tracking signal with 4 MHz frequency offset, delivered on the rear panel.
- An auxiliary signal with very low output impedance, delivered on the rear panel.

Main output :

The main output is available with five pushbutton selectable impedances : 75 Ω coaxial, 150 Ω balanced, 600 Ω balanced, 0 Ω/150 Ω balanced (Z < 5 Ω) and 0 Ω/600 Ω balanced (Z < 20 Ω).

Level display : in dBm by four lever/indicator switches, with sign display by light-emitting diodes.

Resolution : 0.01 dB

Dynamic range : 89.98 dB for 75 Ω impedance and 82.99 dB for other impedances.

Output level :

- 75 Ω impedance : + 19.99 dBm to - 69.99 dBm/75 Ω
- 150 Ω impedance : + 13 dBm to - 69.99 dBm/150 Ω
- 600 Ω impedance : + 13 dBm to - 69.99 dBm/600 Ω
- 0 Ω/150 Ω impedance :

Electromotive force equal to that of 150 Ω impedance, that is 3.46 Vrms (+ 13 dBm setting) to 245 µVrms (- 69.99 dBm setting).

Maximum output current : 30 mA rms

- 0 Ω/600 Ω impedance :

Electromotive force equal to that of 600 Ω impedance, that is 6.92 Vrms (+ 13 dBm setting) to 490 µVrms (- 69.99 dBm setting).

Maximum output current : 15 mA rms

Accuracy at 0 dBm for a 10 kHz frequency : ± 0.2 dB

Output level flatness :

- 75 Ω impedance : + 0.05 dB from 50 Hz to 1 MHz
- 150 Ω and 0 Ω/150 Ω impedances : ± 0.05 dB from 200 Hz to 200 kHz
  ± 0.1 dB from 200 kHz to 620 kHz
  ± 0.2 dB from 620 kHz to 1 MHz
- 600 Ω and 0 Ω/600 Ω impedances : ± 0.05 dB from 200 Hz to 110 kHz
  ± 0.3 dB from 110 kHz to 300 kHz

Reflection loss :

- 75 Ω impedance : + 0 dBm to + 20 dBm : - 35 dB from 50 Hz to 1 MHz
  - 0 dBm to - 69.99 dBm : - 45 dB from 50 Hz to 1 MHz
- 150 Ω impedance : - 35 dB from 200 Hz to 200 kHz
  - 30 dB from 200 kHz to 1 MHz
- 600 Ω impedance : - 35 dB from 200 Hz to 110 kHz
  - 30 dB from 110 kHz to 300 kHz

Signal unbalance :

- 150 Ω impedance : - 50 dB from 200 Hz to 620 kHz
- 600 Ω impedance : - 50 dB from 200 Hz to 110 kHz

Attenuator accuracy :

- 0.01 dB steps : ± 0.005 dB per step, ± 0.01 dB maximum error
- 0.1 dB steps : ± 0.01 dB per step, ± 0.02 dB maximum error
- 1 dB steps : ± 0.03 dB per step, ± 0.05 dB maximum error
- 10 dB steps : ± 0.1 dB per step, ± 0.2 dB maximum error from 0 dBm to - 60 dBm.

Tracking output :

Level : + 6 dBm/75 Ω ± 2 dB

Square-wave output :

- Amplitude : 0 V, 5 V or 10 V typical
- Rise time : < 300 ns
- Fall time : < 100 ns

Auxiliary output :

- Impedance : Z < 1 Ω from 50 Hz to 500 kHz
  Z < 1.5 Ω from 500 kHz to 1 MHz
- Level : + 19.99 dBm/75 Ω to 0 dBm/75 Ω, depending on main output level.
- Output current : 50 mA rms maximum

Protection against short-circuits.

- Maximum capacitive loading : 4.7 nF from 50 Hz to 500 kHz
  1 nF from 500 kHz to 1 MHz
- Output level flatness : ± 0.5 dB from 50 Hz to 200 Hz
  ± 0.3 dB from 200 Hz to 1 MHz

SPECTRAL PURITY

Harmonic signals :

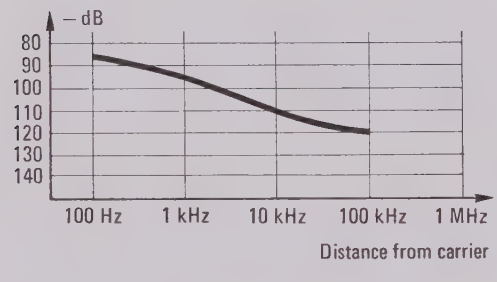
Main output (+ 10 dBm output level) :

- 75 Ω impedance : - 45 dB from 50 Hz to 300 Hz
  - 55 dB from 300 Hz to 1 MHz
- 150 Ω and 0 Ω/150 Ω impedances : - 50 dB from 200 Hz to 1 MHz
- 600 Ω and 0 Ω/600 Ω impedances : - 50 dB from 200 Hz to 300 kHz

Auxiliary output (+ 10 dBm/75 Ω output level) : - 40 dB from 50 Hz to 300 Hz
- 50 dB from 300 Hz to 1 MHz

Nonharmonic signals : - 60 dB for all outputs

Phase-noise in a 1 Hz band :



REMOTE PROGRAMMING

Remote programming of the instrument is achieved either in parallel BCD code (option 010) or through the IEEE bus (option 020).

Parallel BCD programming (option 010) :

- TTL compatible positive logic. "0" logic level : 0 V to + 0.8 V
  "1" logic level : + 2 V to + 5 V
- Parallel BCD code.

IEEE bus programming (option 020) :
Compatible with IEEE standard 488-1975.

SH0 : the instrument never emits data.

AH1 : the instrument accepts data.

T0-TE0 : the instrument is not a Talker.

L1-LE0 : the instrument is a basic Listener which recognizes its own address, does not get disaddressed on reception of the corresponding Talker address, and may be permanently addressed.

SR0 : the instrument has no Service Request capability.

PP0 : the instrument does not respond to Parallel Poll.

RL1 : the Remote mode is controlled through the IEEE bus.

DC1 : the instrument has complete Device Clear capability.

DT1 : the instrument has complete Device Trigger capability.

Frequency programming :

- Resolution : 1 Hz
- Settling time : 10^3 Hz to 10^5 Hz steps : 7 ms
  10^0 Hz to 10^2 Hz steps : 10 ms.

Level programming :

- Resolution : 0.01 dB
- Settling time : 10 dB steps between - 0 dBm and - 60 dBm : 10 ms

Switching between + 0 dBm and + 10 dBm, 1 dB, 0.1 dB and 0.01 dB steps :
5 ms with ALC time constant F > 10 kHz, 800 ms with ALC time constant F < 10 kHz.

Functional mode programming :

- Local/Prog.
- Output level inhibition
- ALC time constant

POWER REQUIREMENTS

Voltage : 115 V or 230 V ($\pm$ 10 %)
Frequency : 50 Hz to 400 Hz
Consumption : 20 VA

Dimensions :
Height : 140 mm
Width : 200 mm
Overall depth : 352 mm
Adaptable to 19" rack (3 U)

Temperature range :
Operation : 0°C to + 50°C
Storage : - 20°C to + 70°C

Weight : 6 kg

CHAPTER III

PRINCIPLE OF OPERATION

III PRINCIPLE OF OPERATION

III-1 INTRODUCTION

The operation of ADRET synthesizers is based on the indirect frequency synthesis, making use of phase-locked loops composed of a voltage-controlled oscillator, a programmable counter and a phase comparator, as shown in figure III-1.

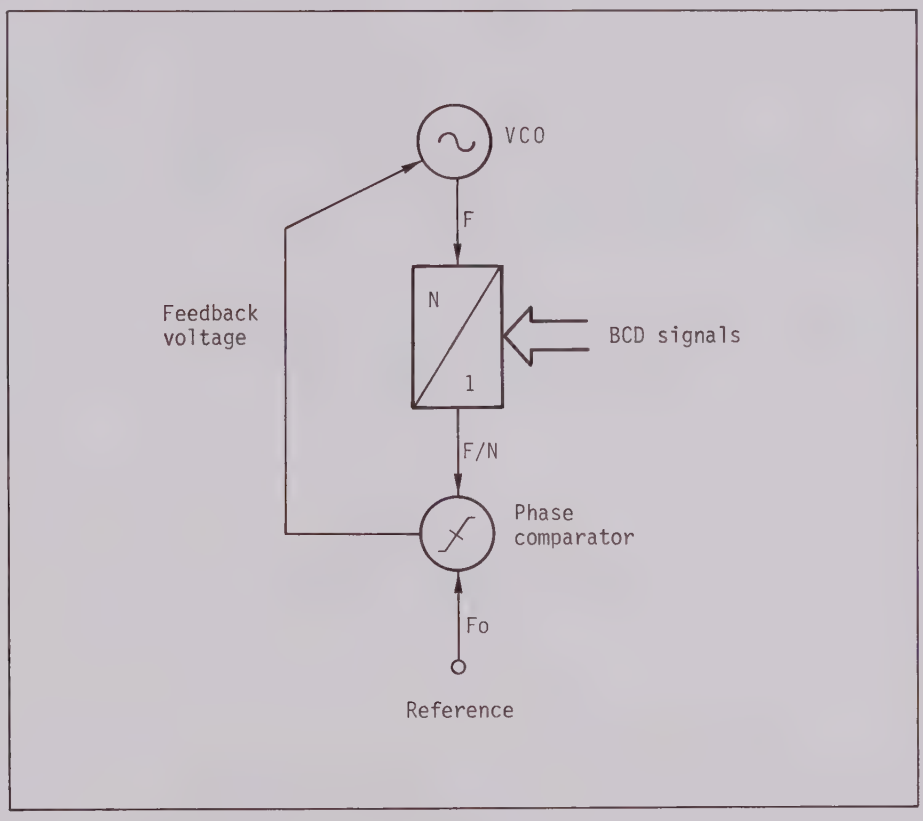


Figure III-1 PHASE-LOCKED LOOP PRINCIPLE

The F frequency delivered by the oscillator is applied to the programmable counter, the N division rate of which is controlled by BCD programming signals. The F/N frequency provided by the programmable counter is then compared to an F_o reference frequency in the phase comparator, which gives a phase-locking voltage allowing to maintain the F frequency of the oscillator equal to N times the F_o reference.

Such a phase-locked loop can thus generate ten different frequencies multiple of F_o when the N division rate of the programmable counter has ten different values.

III-2 PRINCIPLE OF THE 2230A SYNTHESIZER

The general principle of the 2230A synthesizer is represented in plate III-1.

The elaboration of the synthesizer output frequency is achieved through two phase-locked loops : the first loop generates the 10^0 Hz, 10^1 Hz and 10^2 Hz increments of the output frequency, while the second loop generates the 10^3 Hz, 10^4 Hz and 10^5 Hz increments. In the Generator and Sweeper modes, the phase-locking voltage which controls the oscillator of the second loop is replaced by a DC voltage issued from verniers (P1), upon which an external voltage applied to connector (J7) may be superimposed in Sweeper mode.

The mixing of the frequencies elaborated by the two phase-locked loops provides a signal ranging from 4 MHz to 5 MHz in 1 Hz steps, that constitutes the tracking output with 4 MHz offset available on connector (J4). This signal is then heterodyned down in the output mixer with a 4 MHz frequency, which provides a 10 Hz to 1 MHz signal. After amplification, this signal is fed to the shaper delivering the square wave available on connector (J3), to the amplifier of the Z < 1 Ω auxiliary output, and to an attenuator followed with an impedance transformer providing various impedances (75 Ω coaxial, 0 Ω balanced, 150 Ω balanced or 600 Ω balanced) to the main output.

The level of the main output is adjustable from - 69.99 dBm to + 19.99 dBm with 0.01 dB resolution through a digital-to-analog converter which acts upon the ALC loop and varies the level of the 4 MHz signal in 0.01 dB, 0.1 dB and 1 dB steps, whereas the output attenuator provides up to 70 dB attenuation in 10 dB steps.

CHAPTER IV

OPERATING INSTRUCTIONS

IV OPERATING INSTRUCTIONS

IV-1 CONTROLS DESCRIPTION

The various controls and connections on the front and rear panels of the 2230A synthesizer are described in the two following plates :

Plate IV-1 : Front-panel description.
Plate IV-2 : Rear-panel description.

IV-2 INSTALLATION

Connection to mains is achieved on socket (S02) through a standard cord supplied with the instrument. Before applying power, check that mains voltage selector (K8) is on the position corresponding to the mains voltage, remembering that the 115 V and 230 V values admit ± 10 % variation.

The instrument is protected against short-circuits by fuse (F1) of 150 mA nominal value for a 230 V mains voltage, or 300 mA for a 115 V mains voltage.

Switching on the instrument is achieved by pressing key (K1), which lights up indicator (DS1).

IV-3 OUTPUT FREQUENCY

In Local mode, the output frequency can be controlled in three different ways selected by keyboard (K3) : Synthesizer mode, Generator mode, Sweeper mode.

IV-3-1 SYNTHESIZER MODE

In this operating mode, selected by pressing the "SYNTH." key of keyboard (K3), the output frequency is digitally set through lever/indicator switches (K2).

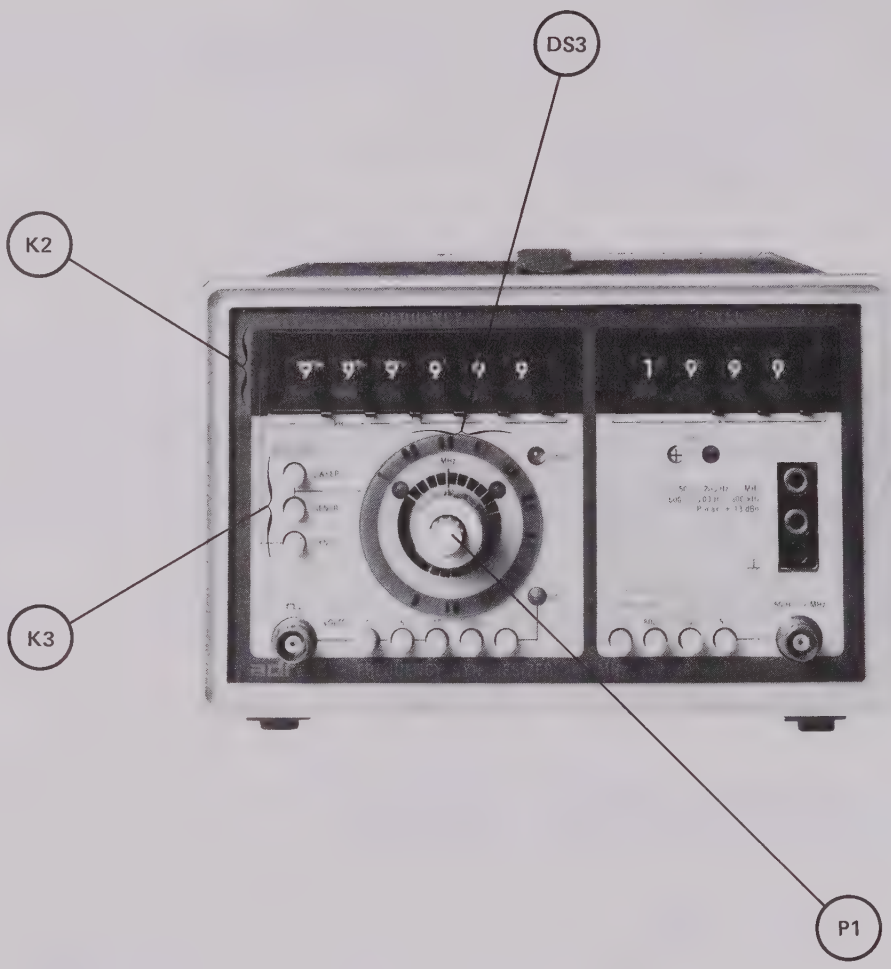
IV-3-2 GENERATOR MODE

This operating mode is obtained by pressing the "GENER." key of keyboard (K3).

The output frequency is determined both by the two verniers (P1) and by the (K2) switches controlling the 1 Hz, 10 Hz and 100 Hz frequency steps, whereas the three other (K2) switches are inhibited.

Two light-emitting diodes (DS3) allow to compare the output frequency to the digital display of switches (K2), this comparison being performed with the three switches controlling the 1 kHz, 10 kHz and 100 kHz frequency steps.

When the output frequency is superior to the digital display of switches (K2), the right-hand LED lights up and the left-hand LED goes out. On the contrary, the left-hand LED lights up and the right-hand LED goes out if the output frequency is inferior to the digital display. When the output frequency is approximately equal to the digital display of switches (K2), a very slow blinking of one LED is observed.



- Press the **GENER.** key of keyboard **K3.**

- Adjust the output frequency through verniers **P1.**

- For accurate determination of the output frequency, operate the three **K2** switches controlling the 1 kHz, 10 kHz and 100 kHz steps so that one of indicator lights **DS3** slowly blinks.

- If necessary, modify the output frequency with the three **K2** switches controlling the 1 Hz, 10 Hz and 100 Hz steps.

Figure IV-1 GENERATOR MODE

IV-3-3 SWEEPER MODE

This operating mode, selected by pressing the "SWEEP." key of keyboard (K3), differs from the Generator mode only in the possibility to sweep the output signal around the frequency selected by verniers (P1) and by the (K2) switches controlling the 1 Hz, 10 Hz and 100 Hz frequency steps.

The frequency sweep is achieved by applying an external voltage to connector (J7) whose input sensitivity is 100 kHz per volt. As shown in figure IV-2, the entire frequency range can be swept by a 10 Vp-p signal with a DC offset depending on the setting of verniers (P1).

For instance, if verniers (P1) are set to 0.2 MHz, sweeping the entire frequency range is achieved by applying a signal with 10 Vp-p amplitude centered on + 3 V.

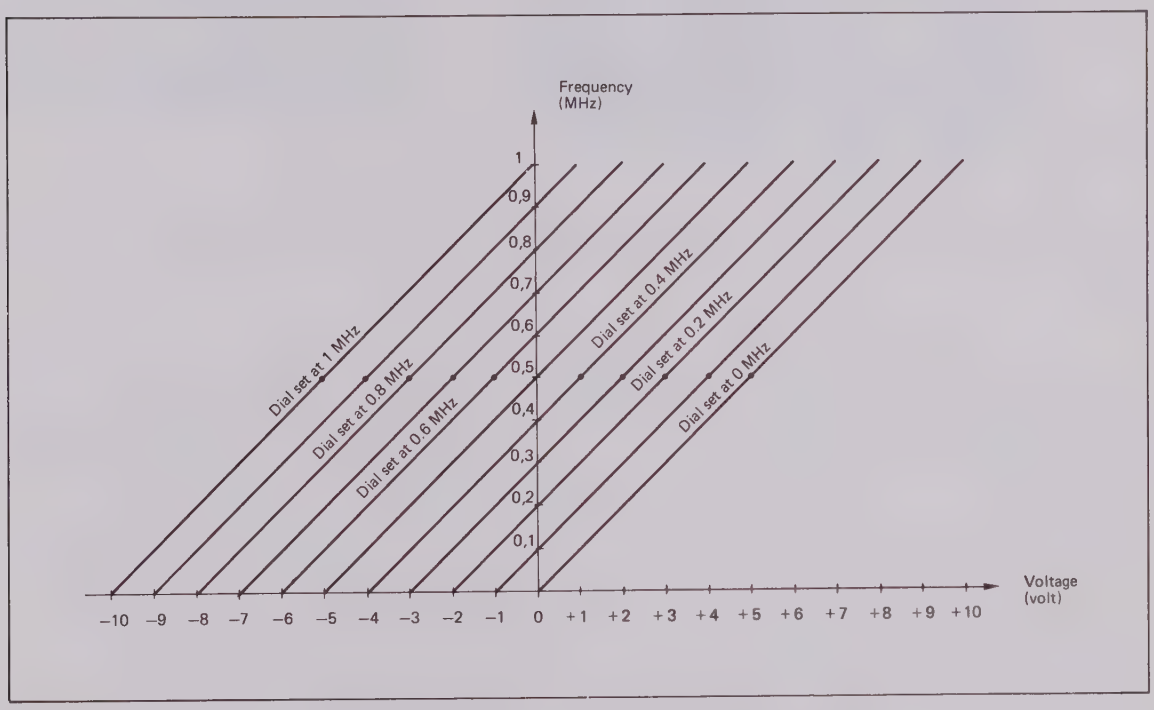


Figure IV-2 OUTPUT FREQUENCY SWEEP

As in the Generator mode, the (DS3) light-emitting diodes allow to compare the output frequency to the digital display of switches (K2), this comparison being performed with the three switches controlling the 1 kHz, 10 kHz and 100 kHz frequency steps.

IV-4 MAIN OUTPUT

Depending on the impedance selected on keyboard (K5), the main output signal is delivered either on coaxial connector (J1) or on balanced connector (J2).

IV-4-1 75 Ω IMPEDANCE

This impedance is selected by pressing the "75 Ω" key of keyboard (K5). The output signal is available on coaxial connector (J1) and the output level is digitally set in dBm/75 Ω through switches (K4), with sign display provided by indicator lights (DS4).

The usable frequency range goes from 10 Hz to 1 MHz, while the output level ranges from + 19.99 dBm (2.735 Vrms/75 Ω) to - 69.99 dBm (86.7 μVrms/75 Ω) with 0.01 dB resolution.

IV-4-2 150 Ω IMPEDANCE

This impedance is selected by pressing the "150 Ω" key of keyboard (K5). The output signal is available on balanced connector (J2) and the output level is digitally set in dBm/150 Ω through switches (K4), with sign display provided by indicator lights (DS4).

The usable frequency range goes from 200 Hz to 1 MHz, while the output level ranges from + 13 dBm (1.730 Vrms/150 Ω) to - 69.99 dBm (122.6 μVrms/150 Ω) with 0.01 dB resolution.

IV-4-3 600 Ω IMPEDANCE

This impedance is selected by pressing the "600 Ω " key of keyboard (K5). The output signal is available on balanced connector (J2) and the output level is digitally set in dBm/600 Ω through switches (K4)., with sign display provided by indicator lights (DS4).

The usable frequency range goes from 200 Hz to 300 kHz, while the output level ranges from + 13 dBm (3.460 Vrms/600 Ω) to - 69.99 dBm (245.2 μVrms/600 Ω) with 0.01 dB resolution.

IV-4-4 0 Ω/150 Ω IMPEDANCE

When both the "0 Ω" and "150 Ω" keys are pressed, connector (J2) delivers a signal with less than 5 Ω output impedance. The electromotive force of this signal is equal to that of the signal with 150 Ω output impedance, that is twice the level displayed in dBm/150 Ω by switches (K4) and indicator lights (DS4).

The usable frequency range goes from 200 Hz to 1 MHz, while the electromotive force ranges from 3.46 Vrms (+ 13 dBm/150 Ω display) to 245 μVrms (- 69.99 dBm/150 Ω display) in 0.01 dB steps.

IV-4-5 0 Ω/600 Ω IMPEDANCE

When both the "0Ω" and "600 Ω" keys are pressed, connector (J2) delivers a signal with less than 20 Ω output impedance. The electromotive force of this signal is equal to that of the signal with 600 Ω output impedance, that is twice the level displayed in dBm/600 Ω by switches (K4) and indicator lights (DS4).

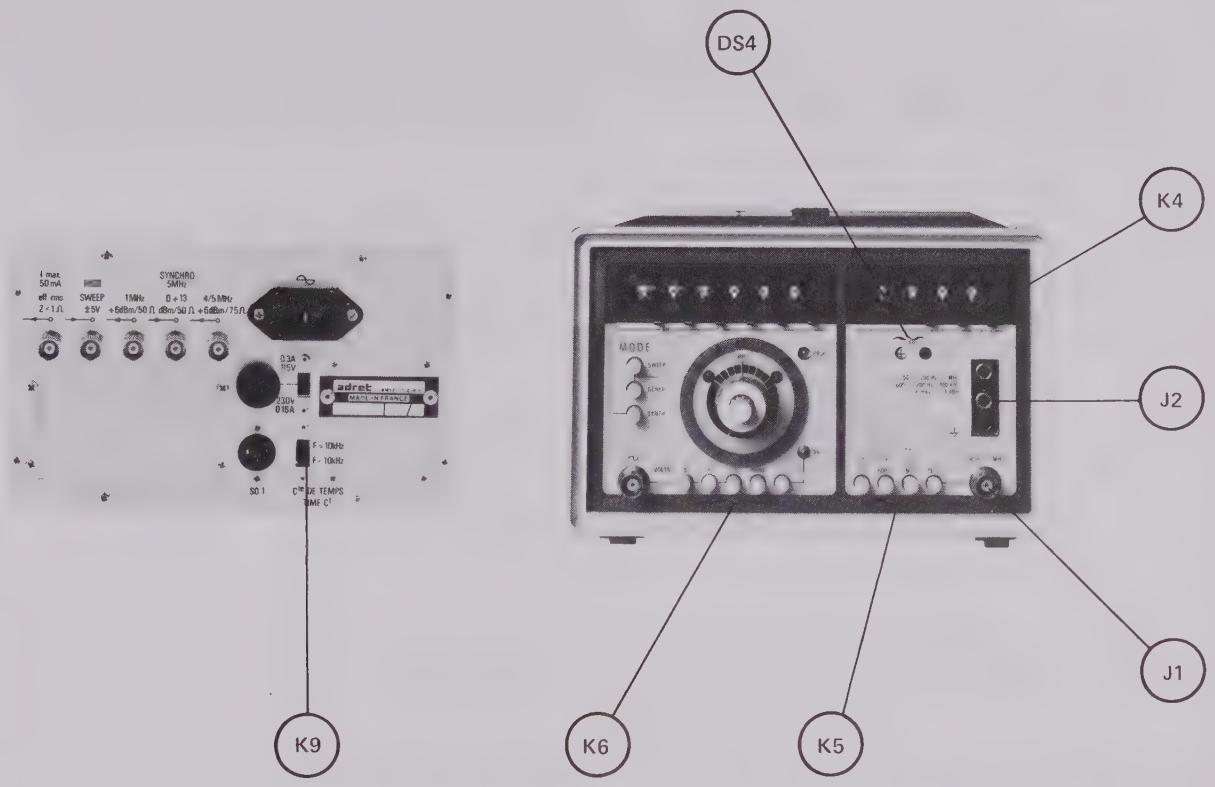
The usable frequency range goes from 200 Hz to 300 kHz, while the electromotive force ranges from 6.92 Vrms (+ 13 dBm/600 Ω display) to 490 μVrms (- 69.99 dBm/600 Ω display) in 0.01 dB steps.

IV-5 SQUARE-WAVE OUTPUT

Coaxial connector (J3) delivers a square wave with the same frequency as the main output signal and with 0 V, 5 V or 10 V amplitude selected on keyboard (K7). The "low" level of this square wave is 0V, which makes it compatible with TTL and C-MOS logical circuits.

IV-6 TRACKING OUTPUT

Coaxial connector (J4) permanently delivers a sinusoidal signal with + 6 dBm/75 Ω output level and 4 MHz frequency offset from the main output signal.



- Select the output impedance through keyboard **K5**. The output signal is delivered on connector **J1** for the 75 Ω impedance and on connector **J2** for the other impedances.
- In Local mode, set switch **K9** to **F < 10 kHz.**
- Adjust the output level through switches **K4**, the sign display being provided by indicator lights **DS4.**
- For suppressing the output signal without switching off the instrument, press key **K6.**

Figure IV-3 MAIN OUTPUT

IV-7 Z < 1 Ω AUXILIARY OUTPUT

A sinusoidal signal with less than 1 Ω output impedance and with the same frequency as the main output signal is available on coaxial connector (J8).

When the level setting of switches (K4) ranges from + 0 dBm to + 19.99 dBm, the electromotive force of this signal is equal to the level of the main output signal expressed in dBm/75 Ω.

When the level setting of switches (K4) ranges from - 0 dBm to - 69.99 dBm, the electromotive force varies from + 10 dBm/75 Ω to + 0.01 dBm/75 Ω according to the table below.

Setting of switches **K4**	− 0,00	− 9,99	− 10,00	− 19,99	− 20,00	− 29,99	− 30,00	− 39,99	− 40,00	− 49,99	− 50,00	− 59,99	− 60,00	− 69,99
Electromotive force in dBm/75 Ω	+ 10 ↘ + 0,01		+ 10 ↘ + 0,01		+ 10 ↘ + 0,01		+ 10 ↘ + 0,01		+ 10 ↘ + 0,01		+ 10 ↘ + 0,01		+ 10 ↘ + 0,01	

IV-8 ALC TIME CONSTANT

In order to optimize the output level settling time, this instrument is endowed with two ALC time constants selected through rear-panel switch (K9). The longer time constant provides level regulation over the entire frequency range (F < 10 kHz setting), whereas the other is reserved for frequencies higher than 10 kHz (F > 10 kHz setting).

In Local mode, it is well-advised to always set switch (K9) to the F < 10 kHz setting, which allows operation with any output frequency.

IV-9 OUTPUT LEVEL INHIBITION

Pressing front-panel key (K6) permits to suppress the main output signal, the Z < 1 auxiliary output signal and the square-wave signal without switching off the instrument.

IV-10 REFERENCE FREQUENCY

The 1 MHz reference frequency derived from the internal crystal oscillator is permanently available on connector (J6) with approximately 500 mVrms/50 Ω output level.

This internal crystal oscillator can be synchronized to a 5 MHz external reference signal applied to connector (J5) with 220 mVrms to 1 Vrms/50 Ω input level. In that case, the frequency delivered by the various outputs of the synthesizer has the stability of the reference frequency applied to connector (J5).

IV-11 SUPPLY VOLTAGES OUTPUT

Socket (S01), whose pin assignment is indicated in figure IV-4, provides + 12 V, + 6 V and - 12 V regulated voltages destined to external circuits.

Maximum current for each voltage : 100 mA.

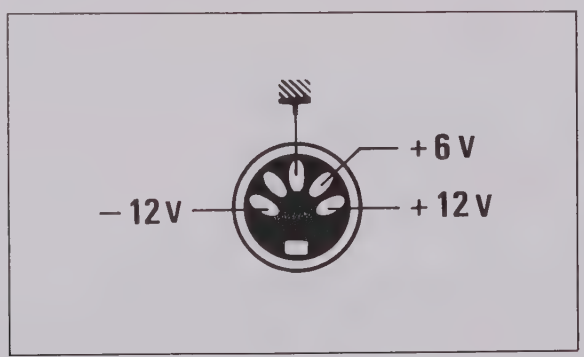


Figure IV-4 SOCKET (S01)

IV-12 PARALLEL BCD PROGRAMMING (OPTION 010)

Selection of the remote programming mode is achieved by applying a "0" logic level to pin 17 of connector (S03) , which lights up indicator (DS2). All manual controls are then inhibited, save on/off switch (K1) , impedance selection keyboard (K5) , square-wave selection keyboard (K7) , and mains voltage selector (K8) .

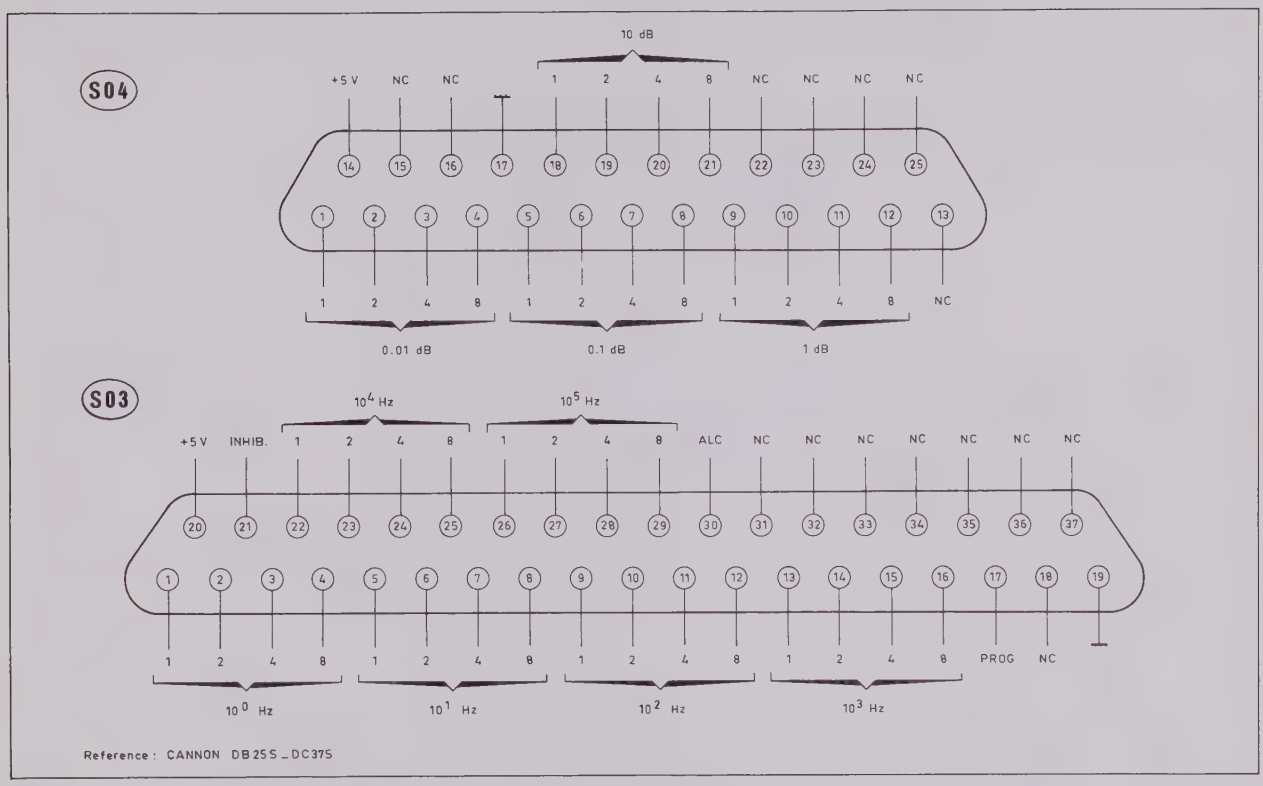


Figure IV-5 PARALLEL BCD PROGRAMMING CONNECTORS

The synthesized frequency programming is achieved in positive logic through TTL compatible signals applied to connector (S03) whose pin assignment is indicated in figure IV-5.

The output level is determined by programming the attenuation with respect to + 20 dBm. This attenuation programming is achieved in positive logic through TTL compatible signals applied to connector (S04) . For instance, programming 9.32 dB provides + 10.68 dBm output level to the main signal.

The output level inhibition is obtained by applying a "0" logic level to pin 21 of connector (S03).

The ALC time constant programming is performed on pin 30 of connector (S03) , a "0" logic level corresponding to F < 10 kHz and a "1" logic level corresponding to F > 10 kHz. The F < 10 kHz time constant may be selected with any output frequency, whereas the F > 10 kHz time constant is destined to the fast level switching of frequencies above 10 kHz.

Pin 20 of connector (S03) and pin 14 of connector (S04) continuously provide a + 5 V regulated voltage which can facilitate programming and be used as a pilot of the instrument operation (50 mA maximum current).

The input circuit of the programming signals consists of a 40097 buffer preceded with a 1N 4448 diode as shown in figure IV-6.

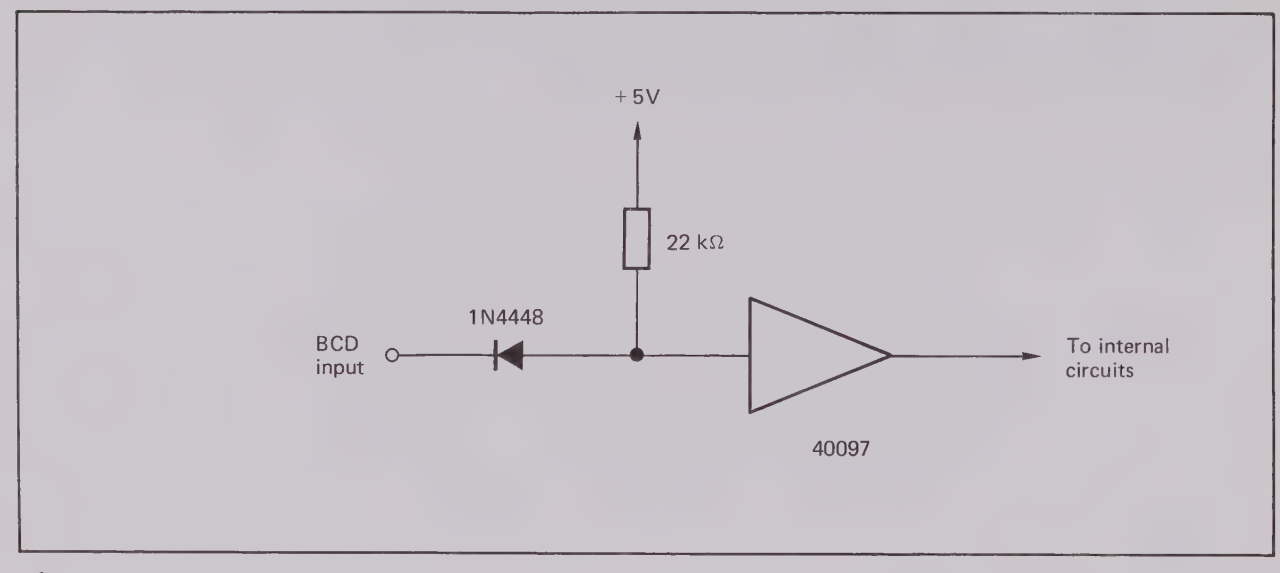


Figure IV-6 PROGRAMMING SIGNALS INPUT CIRCUIT

IV-13 IEEE BUS PROGRAMMING (OPTION 020)

The synthesizer programming through the IEEE bus is achieved in accordance with IEEE standard 488-1975 on connector (S05) whose pin assignment is indicated in figure IV-7.

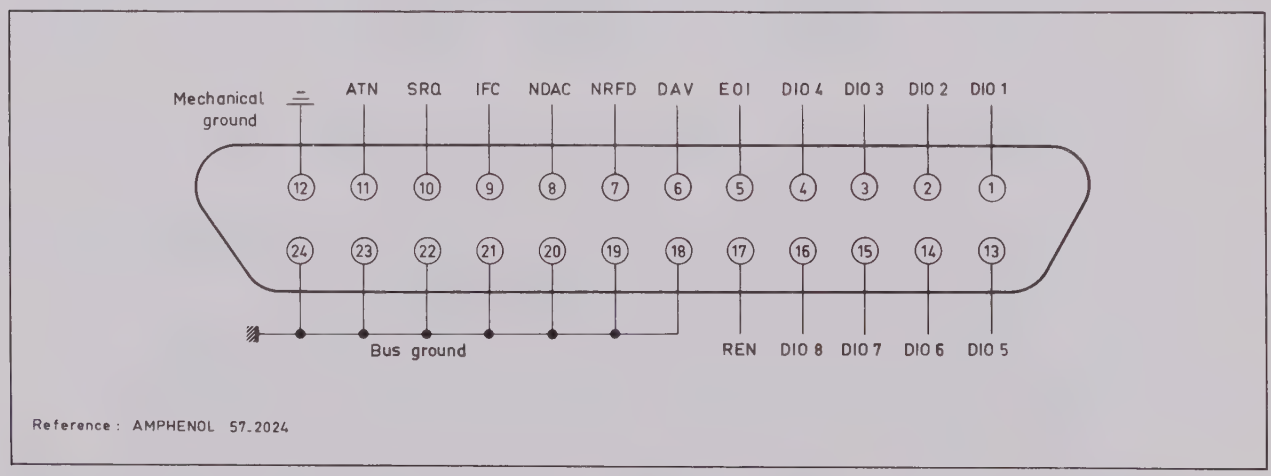


Figure IV-7 IEEE BUS CONNECTOR

IV-13-1 ADDRESSING

The instrument address is selected in binary code among numbers 0 to 30 through five digital switches (K10) . This address is enabled by setting digital switch (K11) to "Addressable".

When switch (K11) is set to "Listen only", the instrument operates in continuous addressing.

Immediately after being addressed, the instrument goes to remote programming mode, which lights up indicator (DS2). The return to Local mode requires either reception of the GTL order (Go To Local), presence of a "1" logic level on line REN, or presence of a "0" logic level on line IFC.

In remote programming mode, all manual controls are inhibited, save on/off switch (K1), impedance selection keyboard (K5), square-wave selection keyboard (K7), and mains voltage selector (K8).

IV-13-2 FREQUENCY PROGRAMMING

The synthesized frequency programming is achieved by sending letter F followed with a whole number representing the frequency in Hz. If the transmitted number comprises a point, a comma, or more generally any character other than a figure, the figures sent after this character are ignored. This particularly prohibits the use of the floating point format.

Several characters may be inserted between letter F and the number representing the synthesized frequency. These characters are ignored by the instrument, provided that they are neither letter A, order CR (Carriage Return), or one of signs < and > .

IV-13-3 ALC TIME CONSTANT PROGRAMMING

Changing the ALC time constant is achieved by inserting sign < or > between letter F and the number representing the synthesized frequency, the < sign corresponding to F < 10 kHz and the > sign corresponding to F > 10 kHz. Without sign < or > inserted between letter F and the number representing the synthesized frequency, the ALC time constant remains unchanged.

The F < 10 kHz time constant may be selected with any output frequency, whereas the F > 10 kHz time constant is destined to the fast level switching of frequencies above 10 kHz.

IV-13-4 OUTPUT LEVEL PROGRAMMING

The output level is determined by programming the attenuation with respect to + 20 dBm. This attenuation programming is achieved by sending letter A followed with a whole number representing the attenuation in mB (0.01 dB). If the transmitted number comprises a point, a comma, or more generally any character other than a figure, the figures sent after this character are ignored by the instrument.

Several characters may be inserted between letter A and the number representing the output level attenuation. These characters are ignored by the instrument, provided that they are neither letter F, order CR (Carriage Return), or question mark ? .

IV-13-5 INHIBITION PROGRAMMING

The output level inhibition is programmed by sending letter A followed with question mark ? . This inhibition ends as soon as another attenuation is programmed.

IV-13-6 DATA ENABLE

The data received by the synthesizer are taken into account only after reception of order CR (Carriage Return), often sent automatically by the calculator at the end of the message, or order GET (Group Executive Trigger) that permits to simultaneously enable the data received by several instruments.

Inversely, orders A and F may be cancelled by sending either order DCL (Device Clear) or order SDC (Selective Device Clear).

IV-13-7 PROGRAMMING EXAMPLES

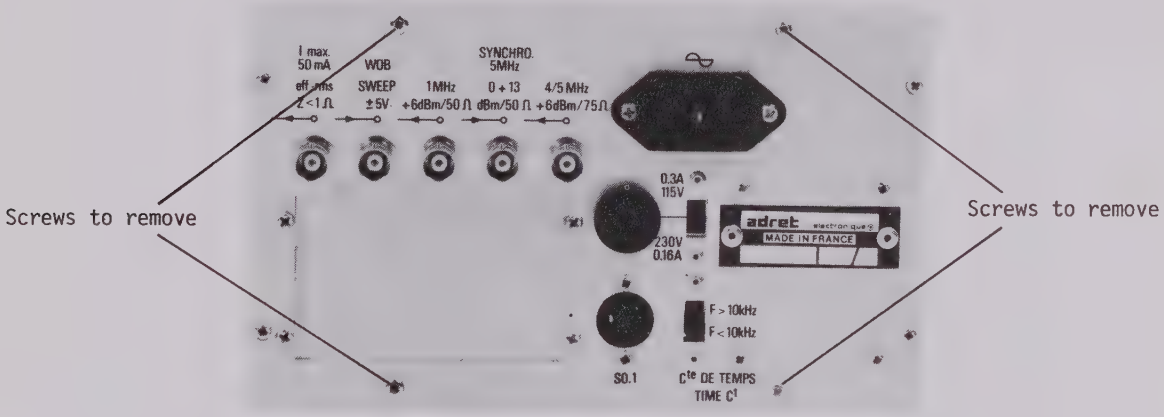
In the following examples, it is assumed that the instrument has been addressed and that the message ends by order CR (Carriage Return).

F < 1 9 7 8 A 0	Frequency 1978 Hz. Time constant F < 10 kHz. Level + 20 dBm.
F 2 0 0 0	Frequency 2000 Hz. Time constant unchanged. Level unchanged.
F R E Q U 5 2 5	Frequency 525 Hz (letters REQU and space are ignored). Time constant unchanged. Level unchanged.
F 1 5 0 0 . 3 5 F 1 5 0 0 , 3 5 F 1 5 0 0 3 5	Frequency 1500 Hz (the figures placed after the point, comma or space are ignored). Time constant unchanged. Level unchanged.
F > 5 9 2 8 1 A ?	Frequency 59281 Hz. Time constant F > 10 kHz. Level inhibition.
A 9 5 1	Frequency unchanged. Time constant unchanged. Level + 10.49 dBm (9.51 dB attenuation).
A T T E N . 9 5 1	Frequency unchanged. Time constant unchanged. Level + 10.49 dBm (letters TTEN and point are ignored).
A 9 5 1 . 2 5 A 9 5 1 , 2 5 A 9 5 1 2 5	Frequency unchanged. Time constant unchanged. Level + 10.49 dBm (the figures placed after the point, comma or space are ignored).
F < 5 0 0 0 A T T E N 9 5 1	Frequency 5000 Hz. Time constant F < 10 kHz. Level 10.49 dBm (letters TTEN are ignored).
F A 1 0 0 0	Frequency 1000 Hz. Time constant unchanged. Level + 10 dBm (10.00 dB attenuation).

IV-14 ADAPTATION TO 19" RACK

The synthesizer 2230 A can be incorporated in a 19" rack with the help of a cabinet reference 01 22309001 for the incorporation of one instrument, or reference 01 22309002 for the incorporation of two instruments. The procedure for inserting the 2230 A in either of these cabinets is as follows.

- Remove the four rear-panel screws holding the top and bottom covers.



- Pull out these two covers.
- Take off the top-cover handle (four screws to remove).
- Take off the four foots of the bottom cover.
- Set the covers back in their place without fixing them.
- Insert the 2230 A in the cabinet and screw back the four rear-panel screws.

APPENDIX

CHART OF ASCII CHARACTERS

BITS				b_7 b_6 b_5	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
b_4	b_3	b_2	b_1	Row \ Column	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE		0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	S	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	:
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	—	o	DEL

IEEE BUS PROGRAMMING WITH CALCULATOR HP 9825A

```
0: "2230A programming with calculator HP9825":
1: "the instrument address is assumed to be 0":
2:
3: fmt 2f.0
4: ent "Frequency in Hertz",F
5: if F<10 or F>=1e6;dsp "Frequency out of range";gto "stop"
6: ent "Level in dBm",A
7: if A>20 or A<=-70;dsp "Level out of range";gto "stop"
8: if F<1e4;wrt 700,"F<",F,"A",2000-100*A;gto 4
9: wrt 700,"F>",F,"A",2000-100*A;gto 4
10: "stop":wrt 700,"A?";wait 1000;gto 4
11: end
```

CHAPTER V

CIRCUIT DESCRIPTION

V-1 INTRODUCTION

In all the schematics and figures of the present manual, the various circuits making up the instrument are designated by the following abbreviations :

A	Amplifier, buffer or shaper
CP	Phase comparator
D	Frequency divider
DP	Programmable frequency divider
DT	Level detector
FL	Filter
M	Mixer
O	Oscillator

V-2 GENERATION 10^0 Hz - 10^1 Hz - 10^2 Hz

Refer to block diagram in plate V-1 and figure V-1, and schematic in plate V-2.

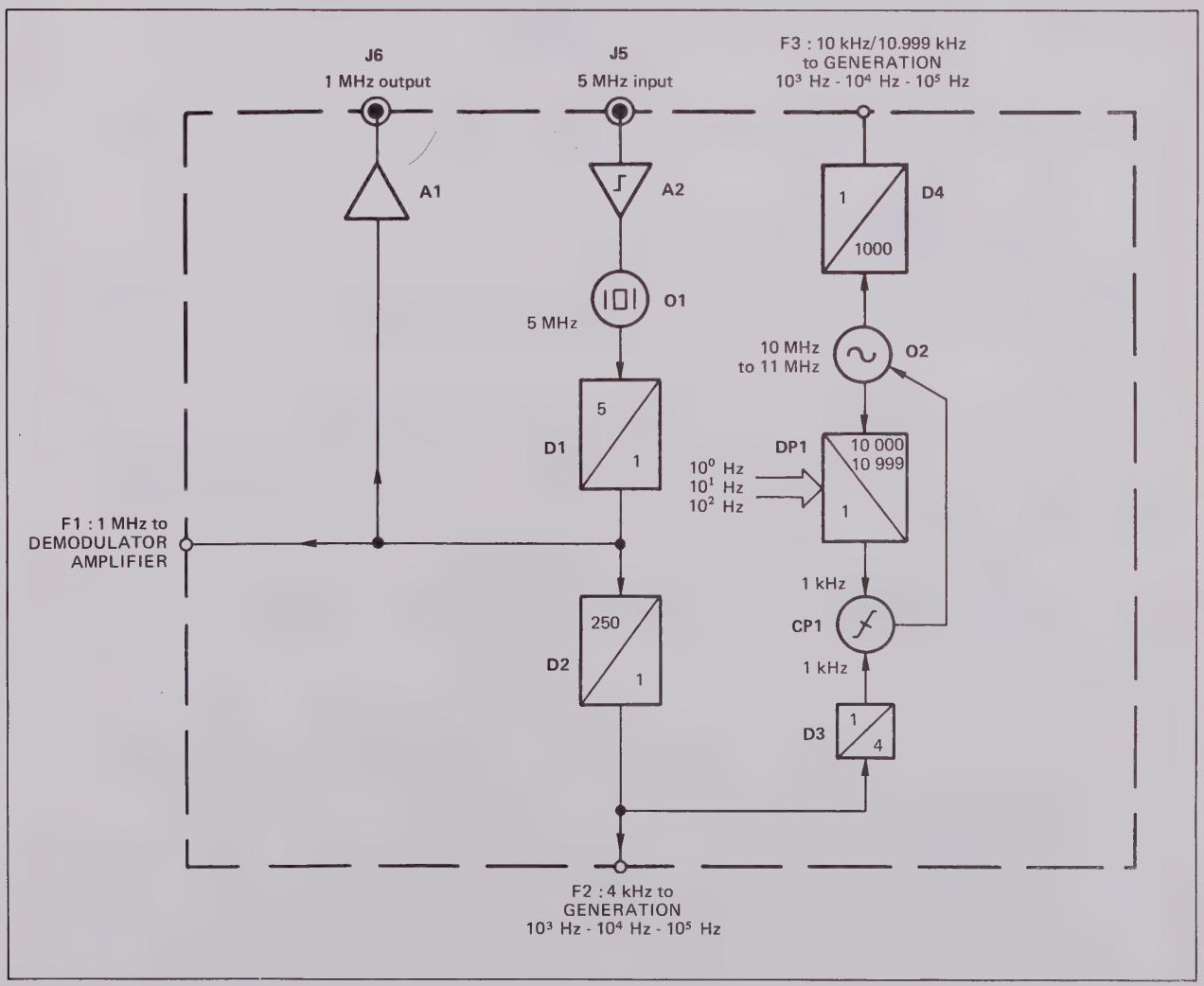


Figure V-1 GENERATION 10^0 Hz - 10^1 Hz - 10^2 Hz

This subassembly includes a phase-locked loop generating the 10^0 Hz, 10^1 Hz and 10^2 Hz increments of the output frequency, and the synthesizer time base.

The time base comprises crystal oscillator O2 which may be synchronized on an external 5 MHz frequency reference with 0 dBm to + 13 dBm/50 Ω input level thanks to shaper A2. The 5 MHz output frequency of oscillator O1 is divided by 5 in divider O1 in order to provide frequency F1 : 1 MHz required by the Demodulator Amplifier, and available on connector (J6) at a level of about + 6 dBm/50 Ω after amplification by A1. This frequency is then divided by 250 in divider D2 which delivers frequency F2 : 4 kHz to the Generation 10^3 Hz - 10^4 Hz - 10^5 Hz subassembly.

The phase-locked loop generating the 10^0 Hz, 10^1 Hz and 10^2 Hz increments of the output frequency includes oscillator O2, programmable counter DP1 and phase comparator CP1. Oscillator O1 generates a 10 MHz to 10.999 MHz frequency which is divided by the division rate N : 10 000 to 10 999 of programmable counter DP1. The output frequency of counter DP1 is then compared in phase comparator CP1 with a 1 kHz reference obtained by dividing frequency F2 : 4 kHz by 4 in divider D3. Phase comparator CP1 therefore provides a DC voltage which locks oscillator O1 onto a frequency equal to N times the reference frequency of 1 kHz.

The frequency generated by oscillator O1 is divided by 1000 in divider D4, which provides frequency F3 : 10 kHz/10.999 kHz routed to the Generation 10^3 Hz - 10^4 Hz - 10^5 Hz subassembly.

PRINCIPLE OF PROGRAMMABLE COUNTER DP1

Programmable counter DP1 includes two dividers with a division rate of 10 or 11, a divider with a division rate of 100 to 109, and two binary module comparators controlling respective dividers by 10 or 11.

During a count cycle, the front divider divides P times by 11, where P is the value of the 10^0 Hz digit programmed in positive logic on the corresponding binary module comparator (integrated circuit SN 16, plate V-2). During the remainder of the cycle, the division rate of this divider is equal to 10.

Similarly, the second divider by 10 or 11 divides Q times by 11 during each count cycle, where Q is the value of the 10^1 Hz digit programmed in positive logic on the binary module comparator SN17.

The divider by 100 to 109 is directly programmed in positive logic by the value R of the 10^2 Hz digit, its division rate being at all times equal to (100+R). The division rate N of programmable counter DP1 can thus be expressed as a function of P, Q and R as follows :

$$N = 10 \left[11Q + 10 (100 + R - Q) - P \right] + 11P$$

P, Q, R : 0 to 9

For example, if the programmed frequency is of the form --- 573 Hz, the front divider divides 3 times by 11 and 1054 times by 10. The second divider by 10 or 11 divides 7 times by 11 and 98 times by 10, while the divider by 100 to 109 continuously divides by 105. The division rate N is thus equal to 10573.

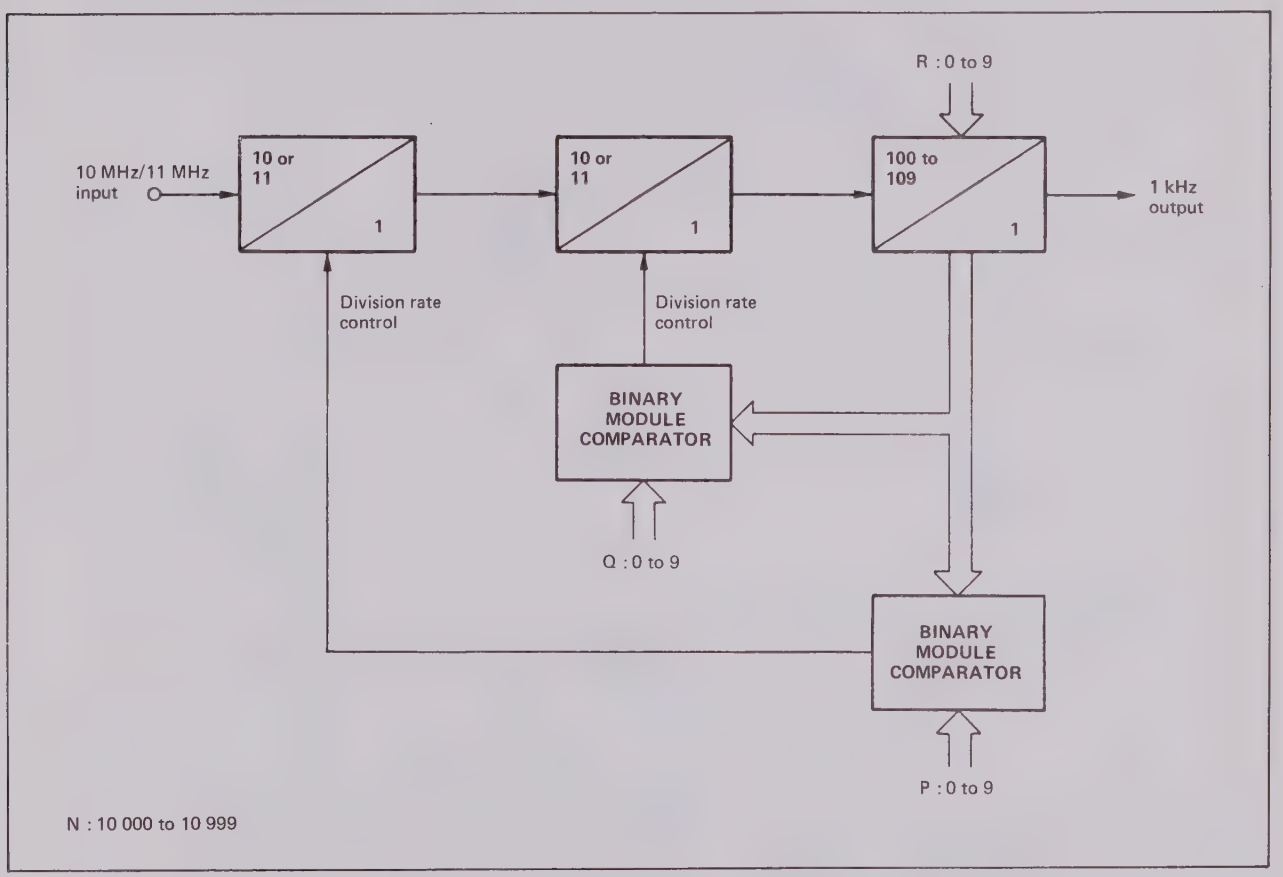


Figure V-2 PRINCIPLE OF COUNTER DP1

The front divider consists of a divider by 4 (integrated circuit SN11, plate V-2) preceded with a divider by 2 or 3 (integrated circuit SN10) whose division rate is controlled by two NAND gates (integrated circuit SN14). Depending on whether the whole must divide by 10 or 11, the sequence of division rates will be either 2 + 3 + 2 + 3 or 3 + 3 + 2 + 3.

The second divider by 10 or 11 is made up of integrated circuits SN12, SN13 and SN15, and operates on the same principle.

The divider by 100 to 109 consists of a BCD counter (integrated circuit SN18) followed by a binary counter (integrated circuit SN19). Inputs D8-D4-D2-D1 of the binary counter are continuously at state 1010, whereas those of the BCD counter receive the programming signals for the 10^2 Hz digit, which produces a division rate equal to (100 + R).

PHASE COMPARATOR PRINCIPLE

The operation of the phase comparator rests up on the generation of a sawtooth which is interrupted by a sampling pulse, as shown in figure V-3.

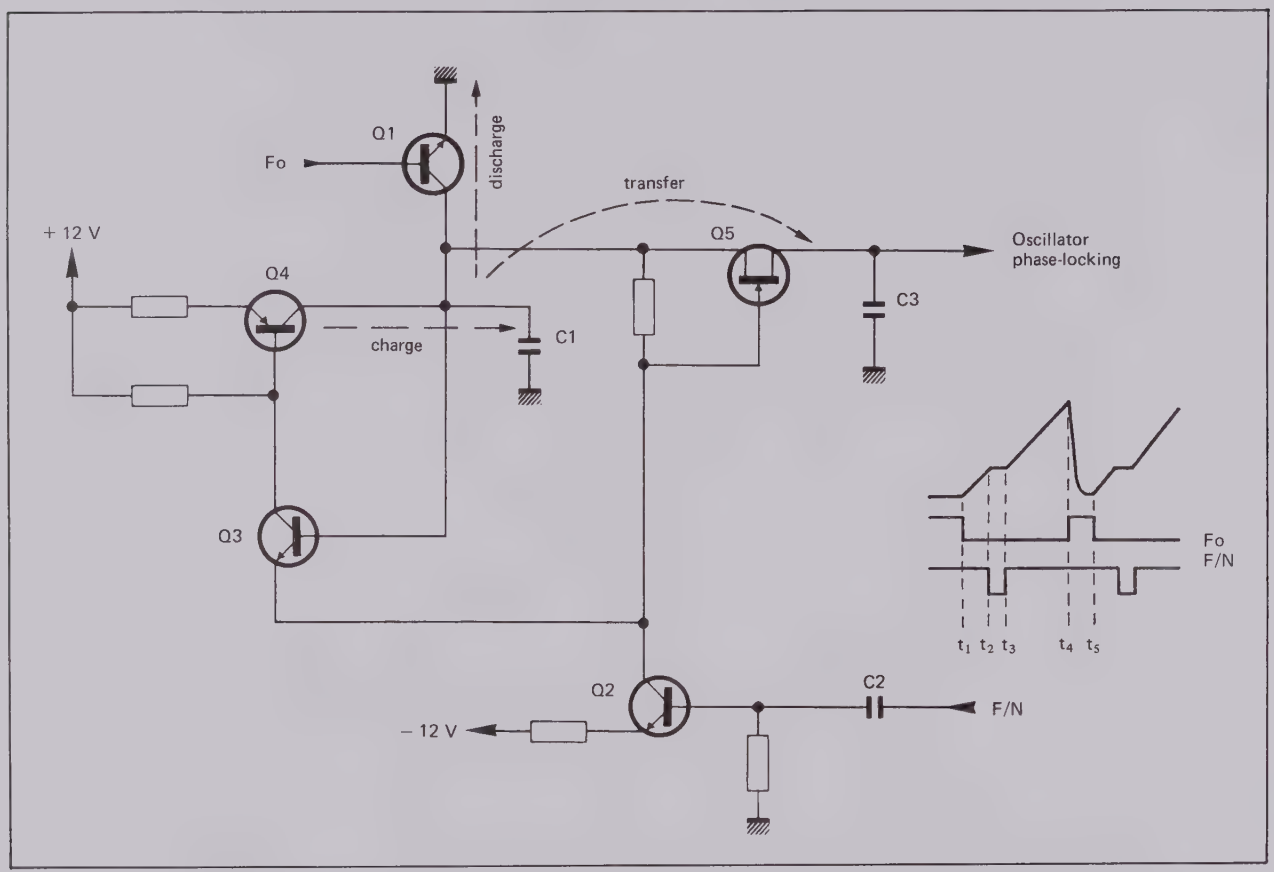


Figure V-3 PRINCIPLE OF PHASE COMPARATOR

At time t_1, the negative edge of the reference F_o cuts off transistor Q1, which starts the sawtooth by enabling capacitor C1 to charge at constant current.

At time t_2, the sawtooth is interrupted by the negative edge of the signal F/N from the programmable counter, which cuts off transistors Q2, Q3 and Q4. At the same time, field-effect transistor Q5 starts to conduct and transfers the charge from capacitor C1 to storage capacitor C3.

At time t_3, field-effect transistor Q5 is again cut off, whereas transistors Q2, Q3 and Q4 begin to conduct again, which restarts the sawtooth.

At time t_4, the positive edge of the reference signal F_o saturates transistor Q1 which therefore discharges capacitor C1. Another sawtooth begins at time t_5 on the negative edge of signal F_o.

Any relative phase shift affecting signals F_o and F/N shifts the time interval (t_3 - t_2) towards time t_1 or time t_4. This displacement modifies the DC voltage stored in capacitor C3, which enables the frequency of the controlled oscillator to be corrected.

V-3 GENERATION 10^3 Hz - 10^4 Hz - 10^5 Hz

Refer to block diagram in plate V-1 and figure V-4, and schematic in plate V-3.

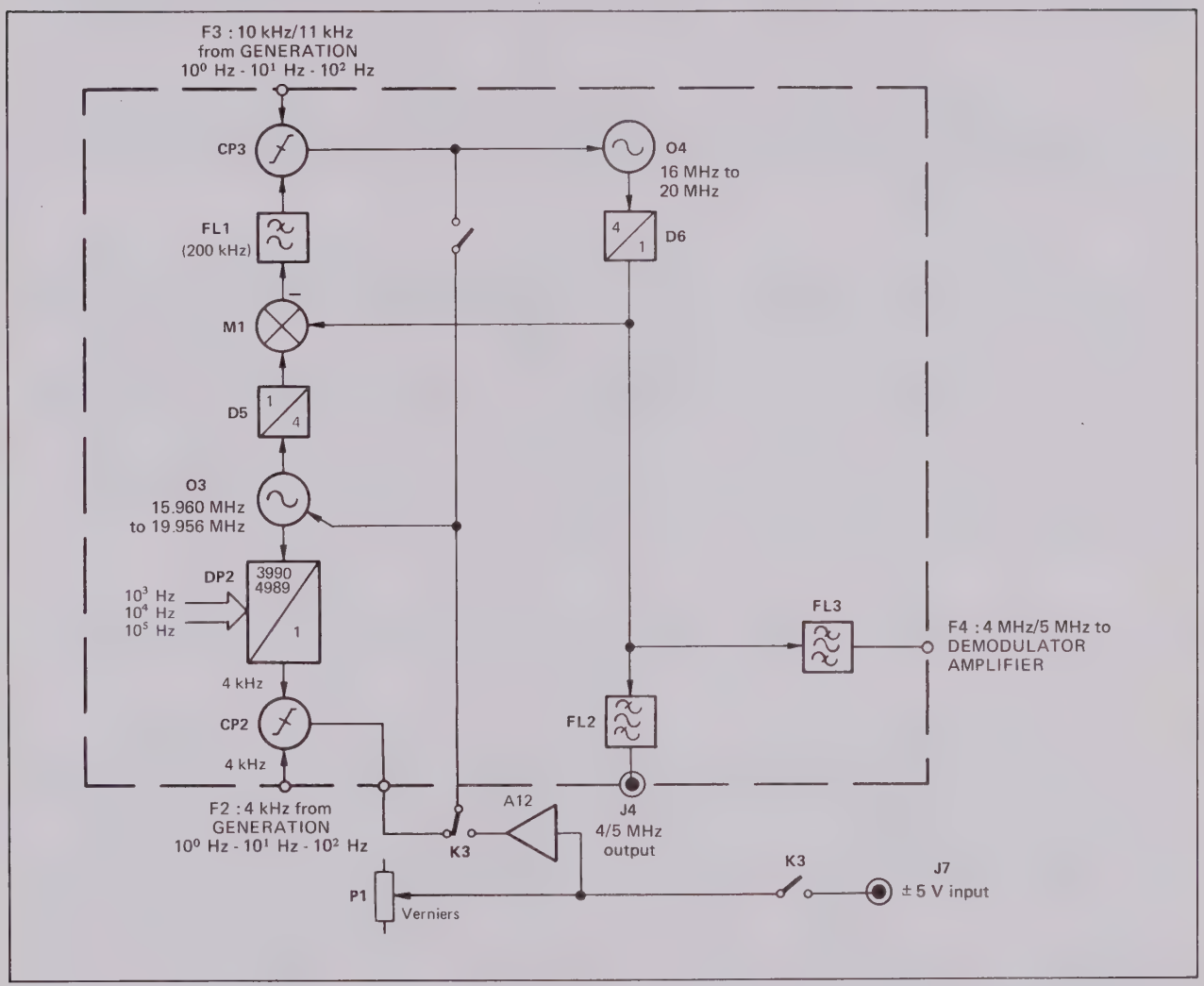


Figure V-4 GENERATION 10^3 Hz - 10^4 Hz - 10^5 Hz

This subassembly generates the 10^3 Hz, 10^4 Hz and 10^5 Hz increments of the output frequency while incorporating the 10^0 Hz, 10^1 Hz and 10^2 Hz increments carried by frequency F3 : 10 kHz/10.999kHz obtained at the output of the previously described subassembly.

The 10^3 Hz, 10^4 Hz and 10^5 Hz increments are generated by means of a phase-locked loop comprising oscillator O3, programmable counter DP2 and phase/frequency comparator CP2. Oscillator O3 delivers a frequency between 15.960 MHz and 19.956 MHz, that is divided by N : 3990 to 4989 in programmable counter DP2. The output frequency of counter DP2 is then compared in phase/frequency comparator CP2 with the reference frequency F2 : 4 kHz coming from Generation 10^0 Hz - 10^1 Hz - 10^2 Hz. In Synthesizer mode, comparator CP2 thus provides a DC voltage locking oscillator O3 onto a frequency equal to N times the reference frequency F2 : 4 kHz. In Generator or Sweeper mode, this control voltage is replaced by the output voltage of amplifier A12 (Control Circuits, plate V-7) providing for gradual variation of the output frequency of oscillator O3.

The combination of the 10^0 Hz, 10^1 Hz and 10^2 Hz increments carried by frequency F3 and the 10^3 Hz, 10^4 Hz and 10^5 Hz increments generated by oscillator O3 is effected by means of a second phase-locked loop comprising oscillator O4, divider D6, mixer M1, filter FL1 and phase/frequency comparator CP3.

Oscillator O4 delivers a frequency variable from 16 MHz to 20 MHz, that divider D6 divides by 4 in order to provide a 4 MHz to 5 MHz frequency. Mixer M1, made of an exclusive OR gate, beats this frequency with a 3.990MHz to 4.989MHz signal obtained by dividing the output frequency of oscillator O3 by 4 in divider D5.

Low-pass filter FL1 selects the difference frequency, and outputs a signal at a frequency variable between 10 kHz and 10.999 kHz, which is then compared in phase/frequency comparator CP3 with frequency F3 : 10 kHz/10.999 kHz coming from the Generation 10^0 Hz - 10^1 Hz - 10^2 Hz subassembly. Comparator CP3 therefore supplies a DC voltage which locks oscillator O4 onto a frequency comprising the 10^0 Hz to 10^2 Hz increments and also the 10^3 Hz to 10^5 Hz increments. In order to prevent oscillator O4 from locking onto a frequency below that generated by oscillator O3, mixer M1 and low-pass filter FL1 provide a signal in phase quadrature with the frequency to be compared. This signal is applied to the J input of one of the flip-flops of comparator CP3, and disables the phase comparison if the output frequency of divider D6 is less than that of divider D5.

The output signal of divider D6 is converted to a sinusoidal signal by band-pass filters FL2 and FL3, which respectively deliver frequency F4 : 4 MHz/5 MHz to connector (J4) on the rear panel of the instrument and to the Demodulator Amplifier subassembly.

During frequency changes involving the 10^3 Hz, 10^4 Hz or 10^5 Hz increments, an electronic switch consisting of transistors Q12 and Q13 (plate V-3) replaces the control voltage from comparator CP3 with an approach voltage obtained from comparator CP2 (Synthesizer mode) or from amplifier A12 (Generator or Sweeper mode). This substitution is intended to bring the output frequency of oscillator O4 close to its final value and is carried out when the difference between the control voltage and the approach voltage exceeds 0.6 volts.

PRINCIPLE OF PROGRAMMABLE COUNTER DP2

Programmable counter DP2 basically comprises two dividers by 10 or 11, a divider by 39 to 49, two BCD adders and two binary module comparators controlling respective dividers by 10 or 11.

During a count cycle, the front divider divides P times by 11, where P is the value of the 10^3 Hz digit programmed in positive logic on the corresponding binary module comparator (integrated circuit SN7, plate V-3). During the remainder of the cycle, the division rate of this divider is equal to 10.

The second divider by 10 or 11 divides Q times by 11 during each count cycle, where Q is the value of the 10^4 Hz digit shifted by 9. This shift is carried out by means of a BCD adder (integrated circuit SN11) whose inputs B8 - B4 - B2 - B1 are set to state 1001, while the inputs A8 - A4 - A2 - A1 receive the BCD programming signals of the 10^4 Hz digit.

For example, if the 10^4 Hz digit is 3, the BCD adder carries out the operation 9 + 3 = 12, and the binary module comparator SN8 receives the digit Q = 2, which gives a division rate of 11 twice per cycle.

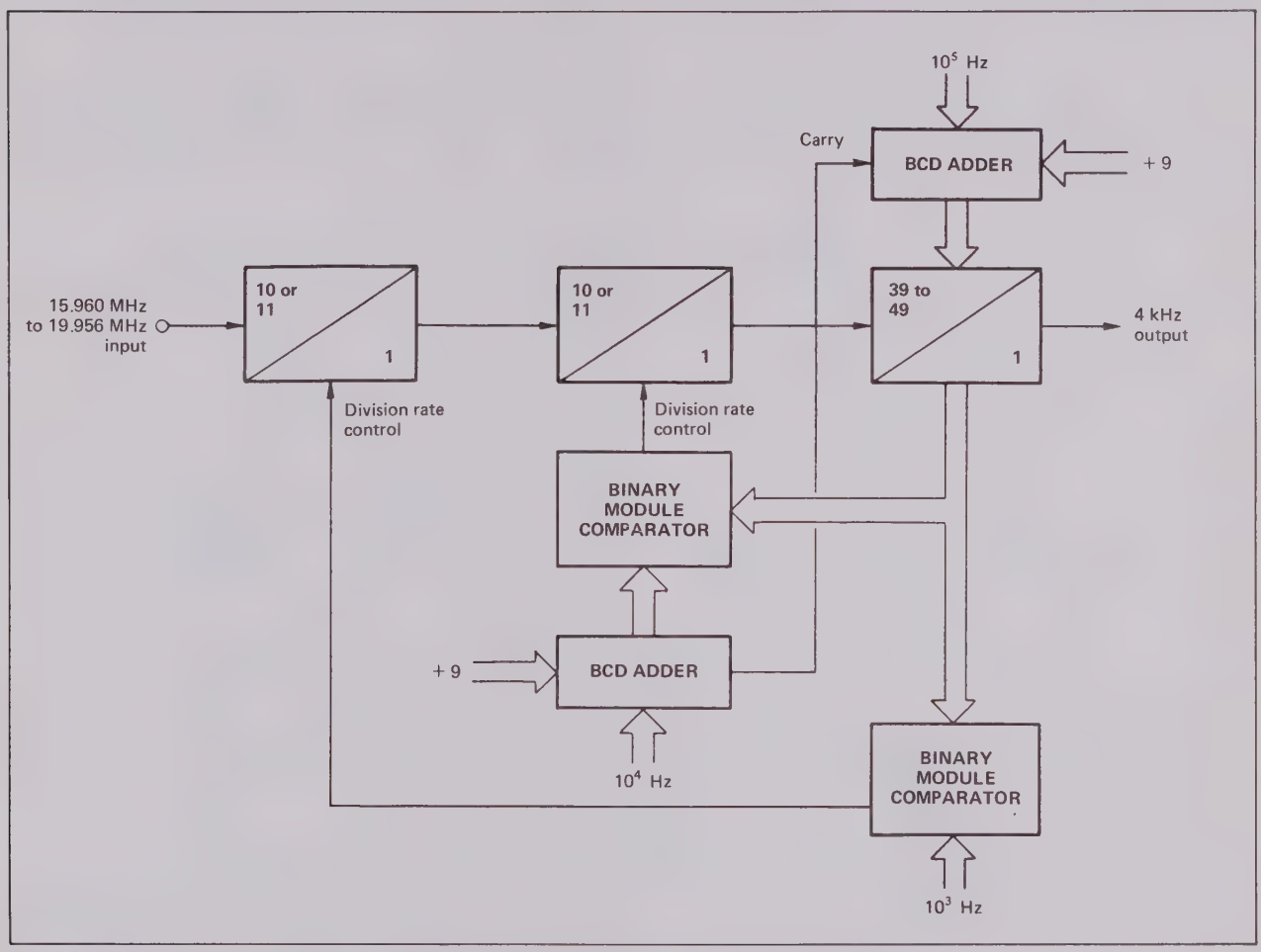


Figure V-5 PRINCIPLE OF COUNTER DP2

The divider by 39 to 49 is directly programmed in positive logic by the value R of the 10^5 Hz digit shifted by 9 or 10. As before, this shift is effected by means of a BCD adder (integrated circuit SN12) whose inputs B8 - B4 - B2 - B1 are set to state 1001. The input Cin receives the carry from adder SN11, and inputs A8 - A4 - A2 - A1 receive the programming signals of the 10^5 Hz digit. For example, if the 10^5 Hz and 10^4 Hz digits are respectively 5 and 3, the BCD adder achieves the operation 9 + 5 + carry = 15, and the counter by 39 to 49 receives the digit R = 5, which gives a division rate of 39 + R = 44.

The front divider consists of a divider by 4 (integrated circuit SN5) preceded with a divider by 2 or 3, the division rate of which is controlled by two NAND gates (integrated circuit SN5). Depending on whether the whole is to divide by 10 or 11, the sequence of division rates will be 2 + 3 + 2 + 3 or 3 + 3 + 2 + 3. The second divider by 10 or 11 comprises integrated circuits SN3, SN4 and SN6, and operates on the same principle.

The divider by 39 to 49 consists of a BCD counter (integrated circuit SN9) followed by a binary counter (integrated circuit SN10), whose inputs D8 - D4 - D2 - D1 receive the programming signals from adder SN12.

PRINCIPLE OF PHASE/FREQUENCY COMPARATOR

The operating principle of the phase/frequency comparator consists in generating pulses with a width proportional to the relative phase of the two compared signals, then in integrating these pulses so as to obtain a DC voltage permitting the phase-locking of an oscillator.

When the compared frequencies Fo and Fx are identical, the phase/frequency comparator acts as a phase comparator. When these two frequencies are unequal, the phase/frequency comparator indicates which one is larger, whence its appellation "phase/frequency comparator".

As shown in figure V-6,the digital section of the comparator consists of two J-K flip-flops whose outputs Q1 and Q2 are connected to an AND gate controlling the Reset input of each flip-flop.

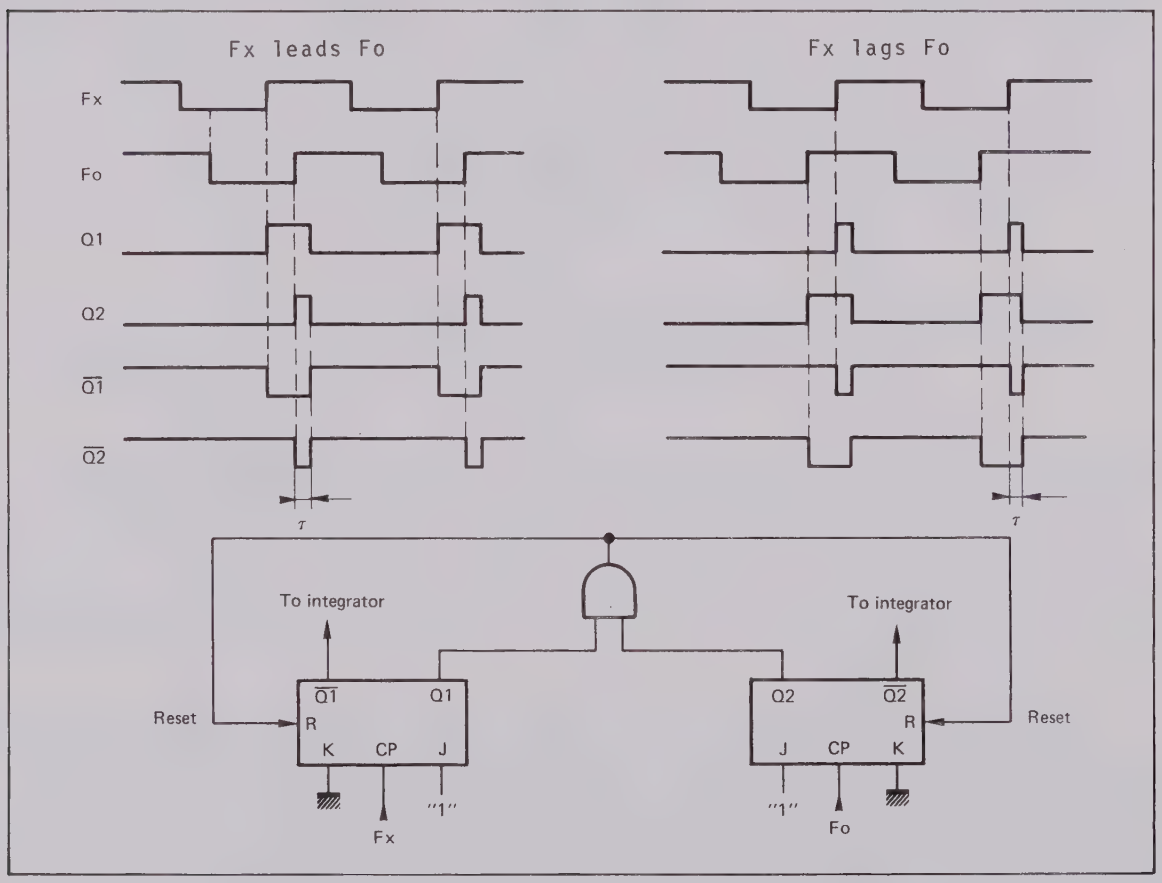


Figure V-6 PRINCIPLE OF PHASE/FREQUENCY COMPARATOR

The signals Fo and Fx to be compared are applied to the CP inputs of respective flip-flops. The K inputs are grounded and the J inputs receive a logic "1", so that the positive edges of the signals Fo and Fx cause a logic "1" to appear at the Q output of the corresponding flip-flop. Due to the reaction of the AND gate upon the Reset inputs, outputs Q1 and Q2 return to state "0" after they have both reached state "1", with a brief delay equal to the propagation time through the AND gate.

The difference between the widths of the pulses at outputs Q1 and Q2 is therefore proportional to the relative phase of the signals Fo and Fx. A DC voltage proportional to this relative phase is therefore obtained by integrating the output pulses by means of a differential integrator.

V-4 DEMODULATOR - AMPLIFIER

Refer to block diagram in plate V-1 and figure V-7, and schematic in plate V-4.

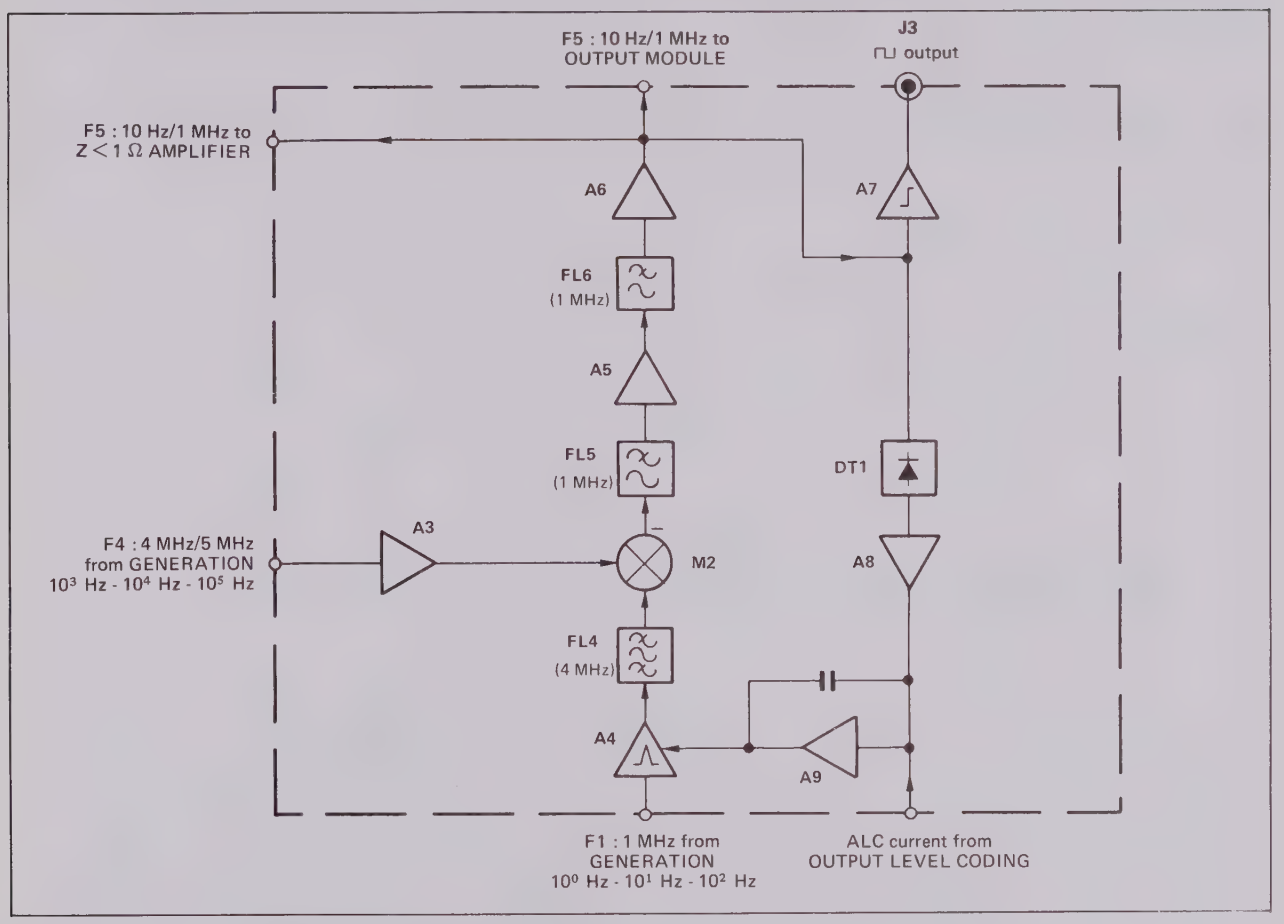


Figure V-7 DEMODULATOR - AMPLIFIER

The Demodulator Amplifier subassembly converts frequency F4, which is variable from 4 MHz to 5 MHz in steps of 1 Hz, to output frequency F5 : 10 Hz/1MHz and provides regulation of the output level.

Mixer M2 and low-pass filter FL5 carry out a substractive mixing of frequency F4 : 4 MHz/ 5 MHz coming from buffer A3 with a 4 MHz signal obtained by multiplying by 4 frequency F1 : 1 MHz issued from the Generation 10^0 Hz - 10^1 Hz - 10^3 Hz subassembly, this frequency multiplication being carried out by harmonic generator A4 and band-pass filter FL4. Frequency F5 : 10 Hz/1MHz obtained at the output of low-pass filter FL5 is amplified by amplifier A5, filtered through low-pass filter FL6 and again amplified by amplifier A6, providing an output signal between 550 mVrms and 5.5 Vrms, depending on the level set on switches (K4). The output signal of amplifier A6 is routed to the Output Module, to Z < 1 Ω Amplifier, and to shaper A7 providing square-wave signals at an amplitude of 5 V or 10 V to connector (J3).

The level of the signal at the output of amplifier A6 is detected by means of a full-wave detector DT1 whose outputs are connected to differential amplifier A8. This provides an ALC current which, following integration in amplifier A9, regulates the level of the 4 MHz signal applied to mixer M2 and consequently the level of the output signal. In addition to the ALC current from amplifier A8, integrator A9 receives a current proportional to the 1 dB, 0.1dB and 0.01dB increments of the output level from the Output Level Coding subassembly.

The ALC time constant is controlled by the parallel connection of a 10 µF capacitor with the integrating capacitor of amplifier A9, which has a value of 0.1 µF . The parallel connection of the 10 µF capacitor provides a long ALC time constant enabling the output level to be regulated over the entire frequency range. On the other hand, the switching out of circuit of this capacitor provides for rapid switching of frequencies above 10 kHz.

The output level inhibition is obtained by cutting off transistor Q1, which disables integrator A9 and removes the 4 MHz signal from mixer M2.

V-5 OUTPUT LEVEL CODING

Refer to block diagram in plate V-1 and figure V-8, and schematic in plate V-5.

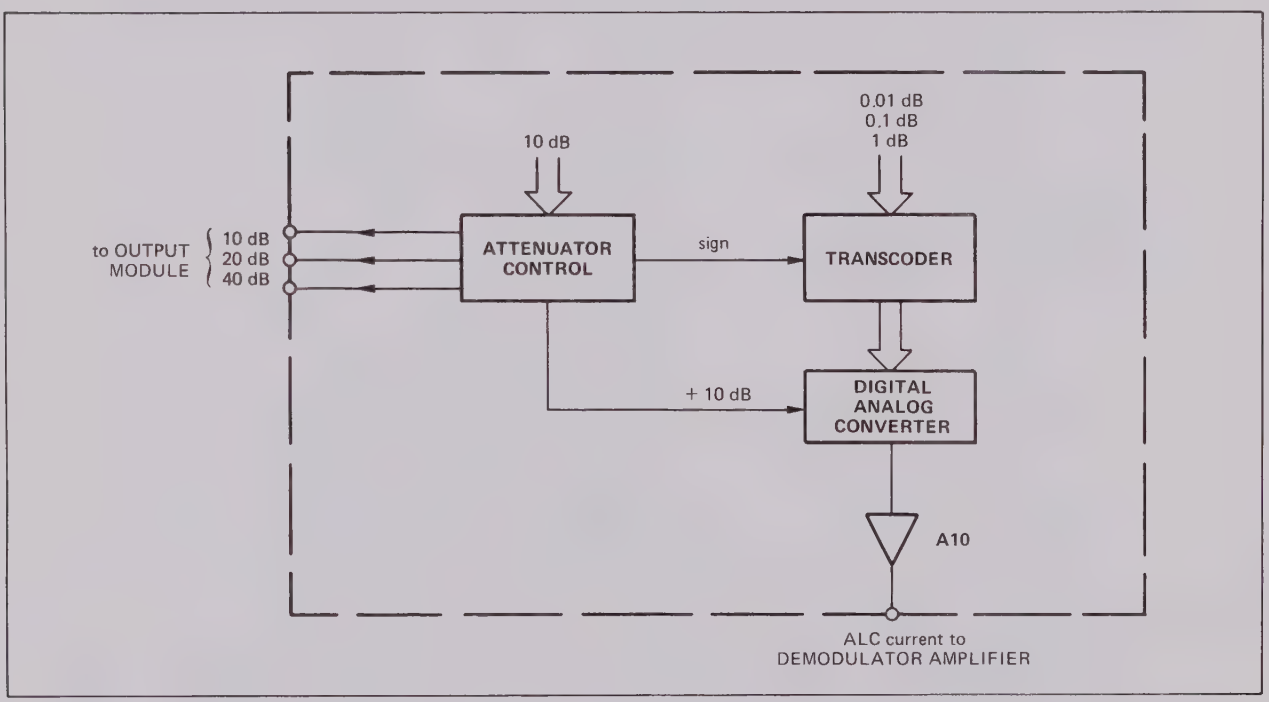


Figure V-8 OUTPUT LEVEL CODING

The Output Level Coding subassembly comprises attenuator control circuitry and a digital/analog converter which outputs a current proportionnal to the 1 dB, 0.1 dB and 0.01 dB increments of the output level.

The attenuator is controlled by means of a BCD/decimal decoder (integrated circuit SN1) and OR gates (integrated circuits SN2 and SN3) which switch the attenuating cells as a function of the output level 10 dB steps, as shown in the table of figure V-9. The signal obtained at output 0 of the BCD/decimal decoder is also sent to the digital/analog converter so as to increase by 10 dB the ALC current sent to the Demodulator Amplifier when the output level is between + 10 dBm + 20 dBm.

Setting of 10 dB steps	+ 10 dB ALC current	10 dB cell	20 dB cell	40 dB cell
+ 1	1	0	0	0
+ 0	0	0	0	0
- 0	0	1	0	0
- 1	0	0	1	0
- 2	0	1	1	0
- 3	0	0	0	1
- 4	0	1	0	1
- 5	0	0	1	1
- 6	0	1	1	1

Figure V-9 CODING OF 10-dB STEPS

The digital/analog converter comprises an operational amplifier (integrated circuit SN5) whose non-inverting input is connected to a resistor network switched by C-MOS switches (integrated circuits SN9 to SN13). The switching operation is controlled by a code converter consisting of three type 4561 integrated circuits providing a positive or negative count of the value of the 1 dB, 0.1 dB and 0.01 dB increments of the output level. In local mode between + 0 dBm and + 19.99 dBm, this value is counted in the positive sense, the type 4561 integrated circuits providing the 9's complement of the input signals. In local mode between - 0 dBm and - 69.99 dBm, and in Remote programming mode, the type 4561 integrated circuits are transparent and the value of the 1 dB, 0.1 dB and 0.01 dB steps is counted negatively.

Depending on the state of the 0 output of the BCD/decimal decoder SN1, the analog signal obtained from operational amplifier SN5 is transmitted directly to follower amplifier A10, or is first attenuated by 10 dB by means of resistors R20 and R21. In both cases, follower amplifier A10 supplies to the Demodulator Amplifier a current which is proportional to the level of the signal at the output of amplifier A6.

V-6 OUTPUT MODULE

Refer to block diagram in plate V-1 and figure V-10, and schematic in plate V-6.

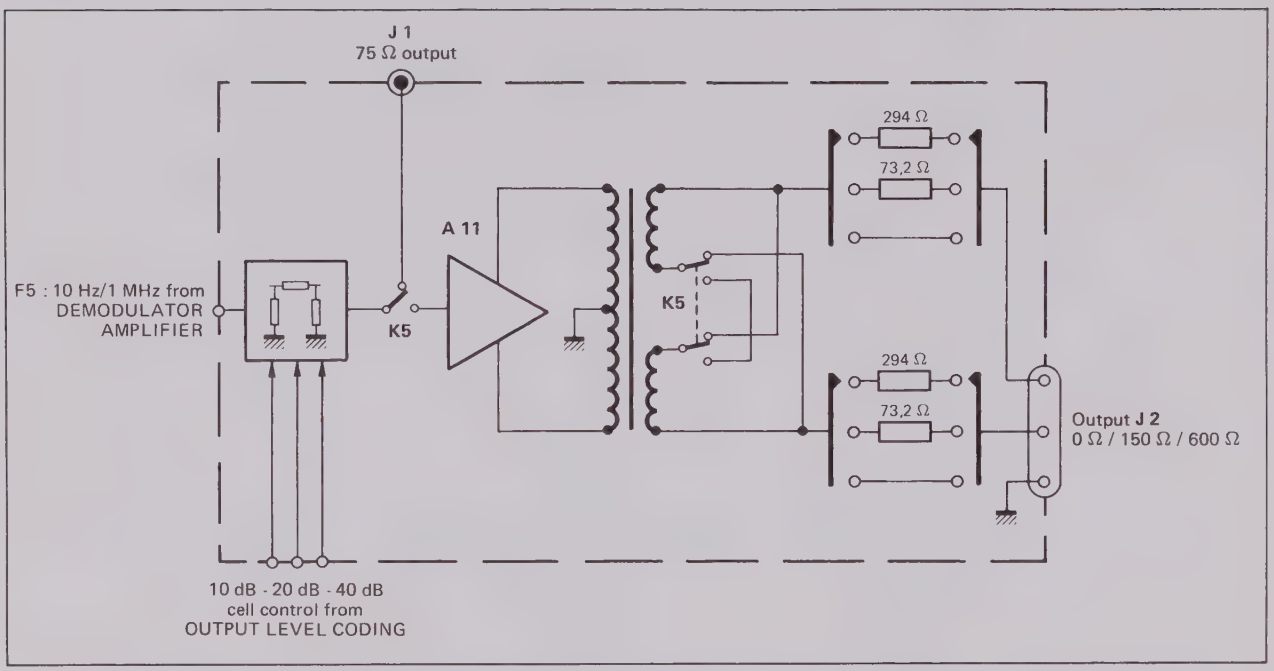


Figure V-10 OUTPUT MODULE

This module includes the output attenuator and the impedance converter circuit which enables the output signal of the synthesizer to be supplied at four different impedances.

The output attenuator includes three π cells with 75 Ω characteristic impedance providing respectively 10 dB, 20 dB and 40 dB attenuation. Each of these cells is controlled by means of a - 12 V voltage issued from the Output Level Coding subassembly.

The impedance converter circuit consists of symmetrical amplifier A11, a transformer with four windings, and impedance selection keyboard (K5). In order to avoid all risk of the transformer core saturating, amplifier A 11 has an automatic DC current centering circuit consisting of operational amplifier SN2.

When an impedance of 75 Ω is selected on keyboard (K5), the signal provided by the output attenuator is applied directly to connector (J1). For all other impedances, this signal is routed to amplifier A11 and the impedance converter before being applied to connector (J2).

When the "150 Ω" key of keyboard (K5) is pressed, the two secondary windings of the transformer are connected in parallel and two 73.2 Ω resistors are connected to the output. These resistors are short-circuited if the "0 Ω" key is also pressed. When the "600 Ω" key is pressed, the two secondary windings are connected in series and two resistors of 294 Ω are connected to the output, these resistors being short-circuited if the "0 Ω" key is also pressed.

V-7 Z < 1 Ω AMPLIFIER

Refer to schematic in plate V-9.

This subassembly comprises an amplifier using complementary transistors which receives frequency F5 : 10 Hz/1 MHz from the Demodulator Amplifier. It provides a signal with 0 dBm/75 Ω to + 20 dBm/75 Ω electromotive force, depending on the level of the main output signal, at an impedance of less than 1 Ω.

V-8 PARALLEL BCD PROGRAMMING (OPTION 010)

Refer to schematic in plate V-12.

This option enables the logic signals from the manual controls of the synthesizer to be replaced by external parallel BCD signals applied to programming connectors (S03) and (S04) .

V-9 IEEE BUS PROGRAMMING (OPTION 020)

Refer to block diagram in figure V-11, and schematics in plates V-10 and V-11.

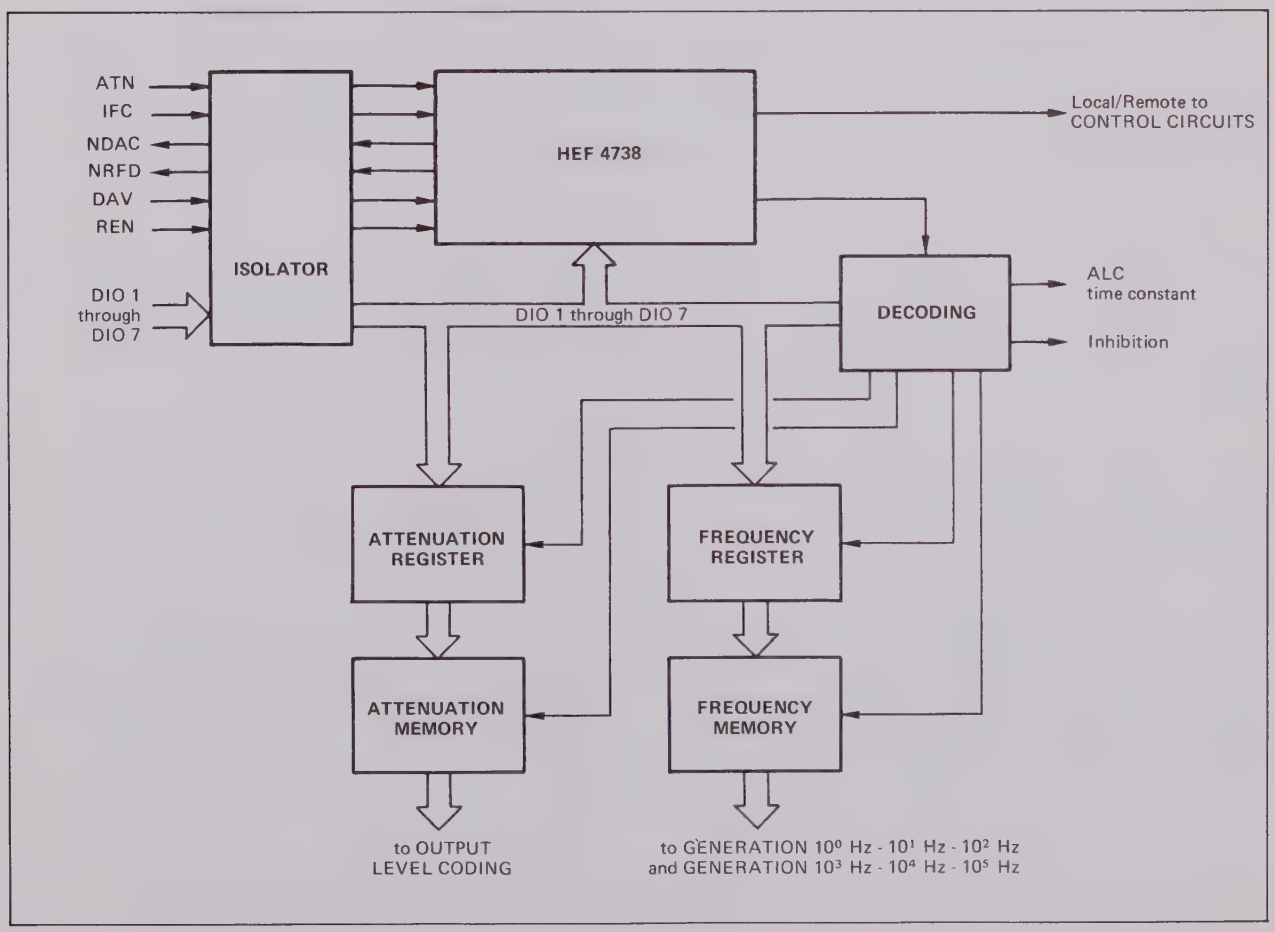


Figure V-11 IEEE BUS PROGRAMMING

This option, consisting of two subassemblies, converts the data supplied by the IEEE Bus into parallel BCD signals which are substituted in Programming mode for the logic signals from the manual synthesizer controls.

V-9-1 IEEE BUS ISOLATOR

This circuit comprises a series of Schmitt triggers (integrated circuits SN1 and SN2 , plate V-10), followed by galvanic isolators (transformers T1, T2 and T3) which enable the ground of the IEEE bus to be isolated from that of the synthesizer. For this reason, the various circuits upstream of the galvanic isolators are supplied by a + 5 V floating voltage issued from the IEEE Bus Registers subassembly.

The secondary winging of each transformer is connected in a feedback to a C-MOS gate (integrated circuits SN5, SN6 and SN7) which stores the transient pulse induced in the winding.

V-9-2 IEEE BUS REGISTERS

This circuit converts the data transmitted by the IEEE Bus Isolator subassembly into parallel BCD signals.

The handshake process with the IEEE bus is entirely controlled by the HEF 4738 integrated circuit, with the aid of a 4014 shift-register. These two integrated circuits provide for the recognition of the address selected by switches (K10) , for the Local/Remote control of the synthesizer, and for the control of the Decoding circuit. The HEF 4738 integrated circuit is controlled by a 2 MHz square-wave signal obtained by dividing by 2 the frequency generated by a 4 MHz oscillator (integrated circuit SN30).

The digits and the characters CR, A, ?, F, < and > are decoded by four decoders (integrated circuits SN4 and SN5 , plate V-11) followed by NOR gates (integrated circuits SN6 to SN9) and JK flip-flops (integrated circuits SN10 , SN11 and SN12) . The decoding circuit also controls transfer of data from lines DI01 to DI04 to the output registers, and supplies the Demodulator-Amplifier with the Inhibition and the ALC time constant programming signals.

The output level attenuation transmitted on lines DI01 to DI04 is transferred to the Attenuation Register consisting of 4 shift registers (integrated circuits SN14 and SN15) and to the Attenuation Memory consisting of 16 type D flip-flops (integrated circuits SN20 to SN23), which supplies this attenuation in parallel BCD code to the Output Level Coding subassembly.

The output frequency transmitted on lines DI01 to DI04 is transferred to the Frequency Register consisting of 8 shift registers (integrated circuits SN16 to SN19) and to the Frequency Memory consisting of 24 type D flip-flops (integrated circuits SN24 to SN29), which supplies this frequency in parallel BCD code to the Generation 10^0 Hz - 10^1 Hz - 10^2 Hz and Generation 10^3 Hz - 10^4 Hz - 10^5 Hz subassemblies.

CHAPTER VI

MAINTENANCE

The tests described in the following pages are designed to enable the user to check that the instrument conforms to the technical characteristics set out in chapter II. These tests may be carried out as acceptance tests, as periodic performance checks, or as a control on the instrument characteristics following repairs.

INSTRUMENTS REQUIRED FOR EXECUTING TESTS

TYPE OF INSTRUMENT	REFERENCE	CHARACTERISTICS
Alternostat		0 V to 260 V ; 200 W
Multimeter	FLUKE 8000 A	DC/AC ; accuracy $\pm$ 1%
Oscilloscope	H.P. 180C + 1808A + 1820C	75 MHz bandwidth
Frequencymeter	SCHLUMBERGER FH 2523	10 Hz to 500 MHz ; 9 digits
RF voltmeter	H.P. 3400 A	10 Hz to 10 MHz ; accuracy $\pm$ 1%
Milliwattmeter	WANDEL & GOLTERMANN EPM-1	10 kHz to 300 MHz ; accuracy $\pm$ 0.015 dB
Standard attenuator	SIEMENS D 2054	0 dB to 99.9 dB
Decibelmeter	ADRET 6101B + 6303B + 63032A + 63030B	DC to 11 MHz ; resolution 0.01 dB
Spectrum analyser	ADRET 6100B + 6303B + 6503A + 63032A	DC to 11 MHz ; dynamic range 120 dB
X-Y recorder	H.P. 7041A	Speed 76 cm/s
ECF 136	ADRET	Impedance transformer 75 Ω/150 Ω/600 Ω
ECF 141	ADRET	Asymmetry detector
Frequency difference multiplier	ADRET 4110A	Resolution 10^{-8} to 10^{-12}
Frequency standard	ADRET 3310A	300 Hz to 60 MHz ; stability $\pm$ 5.10^{-9}/24 h
DC source	ADRET 102	Accuracy $\pm$ 5.10^{-5}; output current 50 mA

N° d'ESSAI TEST NUMBER	CONDITIONS	SANCTIONS RESULTS
1	VISUAL CHECK Check the external appearance of the instrument and that protective fuse (F1) is of the correct rating (300 mA for 115V supply, 150 mA for 230 V supply).	
2 45 Hz to 450 Hz 115V - 230V power supply Alternostat Multimeter	MAINS SUPPLY REGULATION Connect the instrument to a 45 Hz/450 Hz power supply through an alternostat, as shown in figure VI-1.	

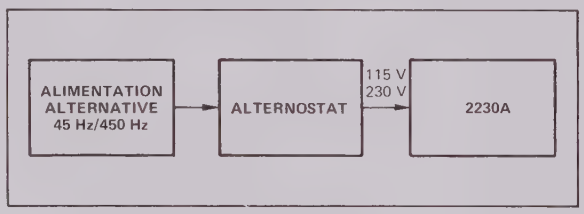


Figure VI-1 MAINS SUPPLY REGULATION

a) Vary the supply frequency between 45 Hz and 450 Hz for supply voltages of 115V and 230V.

Measure the voltages present at connector (S01) of the rear panel :
+ 12V relative to ground.
- 12V relative to ground.
+ 6V relative to ground.

Accuracy :
+ 11.8 V to + 12.5 V
- 11.8 V to - 12.5 V
+ 5.75 V to + 6.25 V

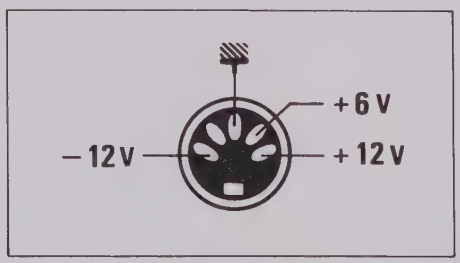


Figure VI-2 CONNECTOR (S01)

b) Repeat the above test using the alternostat to apply voltages of 115V ± 10% and 230V ± 10%.

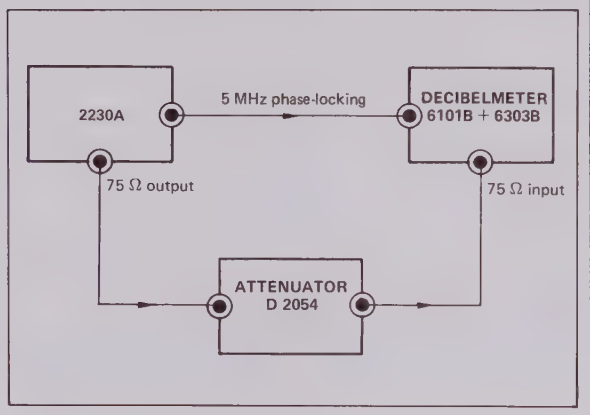
The previously measured voltages must remain substantially identical.

c) Use the multimeter to measure the current drawn by the instrument at both mains supply voltages. Calculate the apparent power consumption by means of the formula P = UI.

P < 20 VA

N° d'ESSAI TEST NUMBER	CONDITIONS	SANCTIONS RESULTS
3 Power supply Alternostat 250 Hz low-pass filter Oscilloscope	RESIDUAL LF RIPPLE With the instrument supplied at 50 Hz, use the 250 Hz low-pass filter and the oscilloscope to measure the LF ripple on the +12V, + 6V and -12V voltages available at connector (S01) .	Residual ripple < 5 mVp-p
4 Frequencymeter DC source	OUTPUT FREQUENCY a) Synthesizer mode : With the frequencymeter and the 2230A synthesizer connected to the same 5 MHz reference frequency, use the frequencymeter to check that the frequency at connector (J1) is the same as that set on switches (K2) . b) Generator mode : Set a frequency of 500 000 Hz on switches (K2) , set potentiometer (P1) to the 0.5 mark, and adjust the vernier of this potentiometer so as to obtain very slow flashing of indicator lights (DS3) . Then measure the output frequency at various positions of potentiometer (P1) , the vernier being left in its initial position. The maximum permissible error relative to the frequency indicated on the graduated dial is ± 50 kHz in all circumstances. If the error is greater than 50 kHz, the amplifier A12 of subassembly 02 7003 (Control Circuits, plate V-7) must be recalibrated as follows : - Set a frequency of 500 000 Hz on switches (K2) , release the three keys of keyboard (K3) , and set potentiometer P1 of subassembly 02 7003 so as to obtain very slow flashing of indicator lights (DS3) . - Depress the "GENER", key of keyboard (K3) , set potentiometer (P1) to 0.5, and adjust the vernier of this potentiometer so as to obtain a very slow flashing of indicator lights (DS3) . Then set potentiometer (P1) to 0.1 and adjust potentiometer P2 of subassembly 02 7003 to obtain an output frequency of 100 kHz. Then check the value of the output frequency when potentiometer (P1) is set to 1.	(P1) / Output frequency 0.1 / 100 ± 50 kHz 0.3 / 300 ± 50 kHz 0.5 / 500 kHz 0.7 / 700 ± 50 kHz 0.9 / 900 ± 50 kHz Output frequency : 1 MHz ± 50 kHz

N° d'ESSAI TEST NUMBER	CONDITIONS	SANCTIONS RESULTS
	c) Sweeper mode : Set a frequency of 500 000 Hz on switches (K2), set potentiometer (P1) to 0.5, and adjust the vernier of the potentiometer so as to obtain very slow flashing of indicator lights (DS3) .	
	Apply -5V to connector (J7) and use the frequencymeter to check that the output frequency is less than 100 kHz. Then apply +5V to connector (J7) and chech that the output frequency is between 900 kHz and 1.1 MHz.	Linearity : ± 10%
5	OUTPUT LEVEL	
Milliwattmeter Standard attenuator Decibelmeter ECF 136	a) In Synthesizer mode, set a frequency of 10 kHz on switches (K2) and select an output impedance of 75 Ω by means of keyboard (K5) . Using the milliwattmeter, measure the output level at connector (J1) when -0.00 dBm and +0.00 dBm are set on switches (K4) .	Accuracy at 0 dBm : ± 0.2 dB
	If necessary, adjust the level at -0.00 dBm using potentiometer P1 and then the level at + 0.00dBm by means of potentiometer P2 of the Demodulator-Amplifier subassembly (plate V-4).	
	b) In Synthesizer mode, set a frequency of 10 kHz on switches (K2) and select an impedance of 150 Ω on keyboard (K5) .	
	Set +3.01 dBm on switches (K4) and measure the output level with the milliwattmeter, matching the impedances by setting the ECF 136 to 150 Ω (insertion loss 3.01 dB).	Measured level : 0 dBm ± 0.2 dB
	If necessary, adjust potentiometer P1 of the Output Module (plate V-6) for calibrating this level.	
	c) In Synthesizer mode, set a frequency of 10 kHz on switches (K2) and select an impedance of 600 Ω on keyboard (K5) .	
	Set 9.03 dBm on switches (K4) and measure the output level using the milliwattmeter, matching the impedances by switching the ECF 136 to 600 Ω (insertion loss 9.03 dB).	Measured level : 0 dBm ± 0.2 dB
	d) In Synthesizer mode, set a frequency of 10 kHz and an impedance of 75 Ω, and check the accuracy of the 0.01 dB and 0.1 dB steps of the output level using the milliwattmeter.	0.01 dB steps : ± 0.005 per step, max.error ± 0.01 dB.

N° d'ESSAI TEST NUMBER	CONDITIONS	SANCTIONS RESULTS
	Then set up the circuit shown in figure VI-3 using the Siemens D 2054 standard attenuator and the Adret selective decibelmeter 6101B + 6303B to check the accuracy of the 1 dB and 10 dB Steps in the output level.	0.1 dB steps : ± 0.01 dB per step, max.error ± 0.02 dB. 1 dB steps : ± 0.03 dB per step, max.error ± 0.05 dB. 10 dB steps : ± 0.1 dB per step, max.error ± 0.2 dB from 0 dBm to -60 dBm.
		
	Figure VI-3 MEASUREMENT OF 1 dB AND 10 dB STEPS	
	The selective decibelmeter is tuned to the output frequency of the 2230A and its reference frequency is locked onto the 5 MHz signal obtained at connector (J6) on the synthesizer.	
6	OUTPUT LEVEL FLATNESS	
Milliwattmeter ECF 136	a) 75 Ω impedance : Set + 0.00 dBm on switches (K4), set switch (K9) to F < 10 kHz, and connect the milliwattmeter to output (J1).	
	Vary the synthesized frequency from 50 Hz to 1 MHz, and measure the variation in the output level relative to the level at 10 kHz.	Level flatness : ± 0.05 dB from 50 Hz to 1 MHz.
	b) 150 Ω impedance : Set + 3.01 dBm on switches (K4), set switch (K9) to F < 10 kHz and connect the milliwattmeter to output (J2), matching the impedances by switching the ECF 136 to 150 Ω (insertion loss 3.01 dB).	
	Vary the synthesized frequency from 200 Hz to 1 MHz and measure the output level variation.	Level flatness : ± 0.05 dB from 200 Hz to 200 kHz.
	c) 600 Ω impedance : Set + 9.03 dBm on switches (K4), set switch (K9)	± 0.1 dB from 200 kHz to 620 kHz.

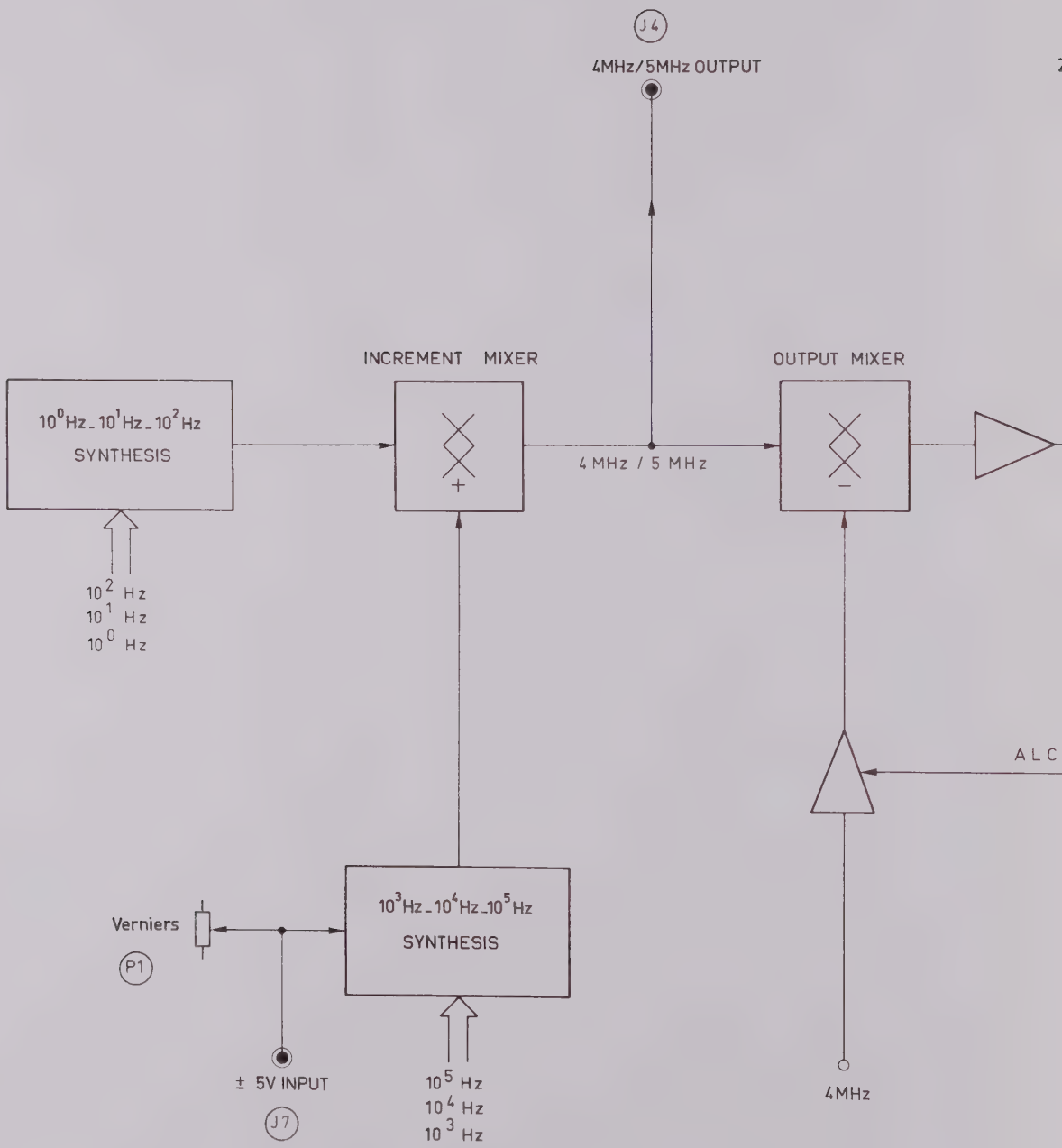
N° d'ESSAI TEST NUMBER	CONDITIONS	SANCTIONS RESULTS
	to F < 10 kHz and connect the milliwattmeter to output (J2), matching the impedances by switching the ECF 136 to 600 Ω (insertion loss 9.03 dB).	± 0.2 dB from 620 kHz to 1 MHz.
	Vary the synthesized frequency from 200 Hz to 300 kHz, and measure the output level variation.	Level flatness : ± 0.05 dB from 200 Hz to 110 kHz. ± 0.3 dB from 110 kHz to 300 kHz.
7	SIGNAL UNBALANCE	
RF voltmeter ECF 141	a) 150 Ω impedance : Set + 6.00 dBm on switches (K4), set switch (K9) to F < 10 kHz and connect the ECF 141 (switched to 150 Ω) to connector (J2).	
	Connect the output of the ECF 141 to the RF voltmeter and measure the signal level relative to 0 dBm/600 Ω while varying the synthesized frequency from 200 Hz to 620 kHz.	Signal unbalance : - 50 dB
	b) 600 Ω impedance : Set + 0.00 dBm on switches (K4), set switch (K9) to F < 10 kHz and connect the ECF 141 (switched to 600 Ω) to connector (J2).	
	Connect the output of the ECF 141 to the RF voltmeter and measure the signal level relative to 0 dBm/600 Ω while varying the synthesized frequency from 200 Hz to 110 kHz.	Signal unbalance : - 50 dB
8	HARMONIC AND NONHARMONIC CONTENT	
Spectrum analyser X-Y recorder ECF 136	a) 75 Ω impedance : Set + 10 dBm on switches (K4) and connect the spectrum analyser to output (J1), ensuring that the impedances are matched.	
	Measure the relative levels of the harmonic and nonharmonic components at various frequencies between 50 Hz and 1 MHz, switch (K9) being set to F < 10 kHz for frequencies less than 10 kHz.	Harmonics at + 10 dBm : - 45 dB from 50 Hz to 300 Hz. - 55 dB from 300 Hz to 1 MHz.
	b) 150 Ω impedance : Set + 10 dBm on switches (K4) and connect the spectrum analyser to output (J2), ensuring that the impedances are matched by switching the ECF 136 to 150 Ω (insertion loss 3.01 dB).	Nonharmonics : - 60 dB
	Measure the relative levels of the harmonic and nonharmonic components at various frequencies	Harmonics at + 10 dBm : - 50 dB

N° d'ESSAI TEST NUMBER	CONDITIONS	SANCTIONS RESULTS
	between 200 Hz and 1 MHz, switch (K9) being set to F < 10 kHz for frequencies less than 10 kHz. c) 600 Ω impedance : Set + 10 dBm on switches (K4) and connect the spectrum analyser to output (J2), ensuring that the impedances are matched by switching the ECF 136 to 600 Ω (insertion loss 9.03 dB). Measure the relative levels of the harmonic and nonharmonic components at various frequencies between 200 Hz and 300 kHz, switch (K9) being set to F < 10 kHz for frequencies less than 10 kHz.	Nonharmonics : - 60 dB Harmonics at + 10 dBm : - 50 dB Nonharmonics : - 60 dB
9	PHASE-NOISE	
Spectrum analyser X-Y recorder ECF 136	Set + 10 dBm on switches (K4), select a 75 Ω impedance on keyboard (K5), and connect the spectrum analyser to output (J1). With switch (K9) set to F < 10 kHz, measure the phase-noise at 100 Hz, 1 kHz, 10 kHz and 100 kHz from carrier at various output frequencies. These measurements may also be carried out at the 150 Ω or 600 Ω output, using the ECF 136 adaptor.	Phase-noise in a 1 Hz band : - 85 dB at 100 Hz - 95 dB at 1 kHz - 110 dB at 10 kHz - 120 dB at 100kHz
10	SQUARE-WAVE OUTPUT	
Oscilloscope	Use the oscilloscope to measure the rise and fall times of the square-wave signals at connector (J3).	Rise time : 300 ns Fall time : 100 ns
11	TRACKING OUTPUT	
RF voltmeter Spectrum analyser X-Y recorder	a) Output level : Use the RF voltmeter to measure the level of the tracking signal available at connector (J4). b) Nonharmonic content : Use the spectrum analyser to measure the relative levels of nonharmonic components of the tracking signal.	Level : + 6 dBm/75 Ω ± 2 dB Nonharmonics : - 60 dB
12	AUXILIARY OUTPUT Z < 1 Ω	
Milliwattmeter Spectrum analyser X-Y recorder	a) Output level : Set a frequency of 10 kHz on switches (K2) at a level of +0.00 dBm on switches (K4). Use the milliwattmeter to measure the level of the signal at connector (J8) for a 75 Ω load.	Level : 0 dBm/75 Ω

N° d'ESSAI TEST NUMBER	CONDITIONS	SANCTIONS RESULTS
	If necessary, adjust this level by means of potentiometer P2 of the Z < 1 Ω Amplifier subassembly (plate V-9).	
	b) Output level flatness : Set + 0.00 dBm on switches (K4), set switch (K9) to F < 10 kHz, and connect the milliwattmeter to connector (J8). Vary the synthesized frequency from 50 Hz to 1 MHz and measure the output level variation relative to 0 dBm.	Level flatness : ± 0.5 dB from 50 Hz to 200 Hz. ± 0.3 dB from 200 Hz to 1 MHz.
	c) Harmonic and nonharmonic content : Set + 10 dBm on switches (K4) and connect the spectrum analyser to output (J8). Measure the relative levels of the harmonic and nonharmonic components at various frequencies between 50 Hz and 1 MHz, with switch (K9) set to F < 10 kHz for frequencies less than 10 kHz.	Harmonics at + 10 dBm : - 40 dB from 50 Hz to 300 Hz. - 50 dB from 300 Hz to 1 MHz. Nonharmonics : - 60 dB
13	1 MHz REFERENCE OUTPUT	
RF voltmeter	Use the RF voltmeter to measure the level of the 1 MHz reference output at connector (J6) for a load of 50 Ω.	Level : 550 mVrms/50 Ω ± 10 %
14	MASTER OSCILLATOR STABILITY	
Frequency difference multiplier Frequency standard	Use the frequency difference multiplier to measure the relative difference ΔF/F between the 5 MHz frequency available at connector (J6) and the 5 MHz signal from the frequency standard. Leave the synthesizer switched on, and measure the difference ΔF'/F between the two frequencies 24 hours later. If necessary, recalibrate the internal Master Oscillator by means of capacitor C13 located on the Generation 10^0 Hz - 10^1 Hz - 10^2 Hz subassembly.	$\left\lvert \frac{\Delta F'}{F} - \frac{\Delta F}{F} \right\rvert < 3.10^{-6}$ after 24 hours of continuous operation.
15	EXTERNAL REFERENCE FREQUENCY	
Oscilloscope Frequency standard	Connect the 5 MHz reference frequency from the frequency standard to connector (J5) on the synthesizer and to channel 1 on the oscilloscope. Connect output (J6) of the synthesizer to channel 2 of the oscilloscope, and check that the two signals appearing on the screen are stationary relative to one another as the level of the 5 MHz reference frequency applied to connector (J5) is varied from 220 mVrms/50 Ω to 1 Vrms/50 Ω.	

CHAPTER VII

PLATES, SCHEMATICS, PARTS LIST


J4
4MHz/5MHz OUTPUT
INCREMENT MIXER
OUTPUT MIXER
10^0Hz_10^1Hz_10^2Hz
SYNTHESIS
+
−
4 MHz / 5 MHz
10^2 Hz
10^1 Hz
10^0 Hz
A L C
Verniers
P1
10^3Hz_10^4Hz_10^5Hz
SYNTHESIS
± 5V INPUT
J7
10^5 Hz
10^4 Hz
10^3 Hz
4MHz

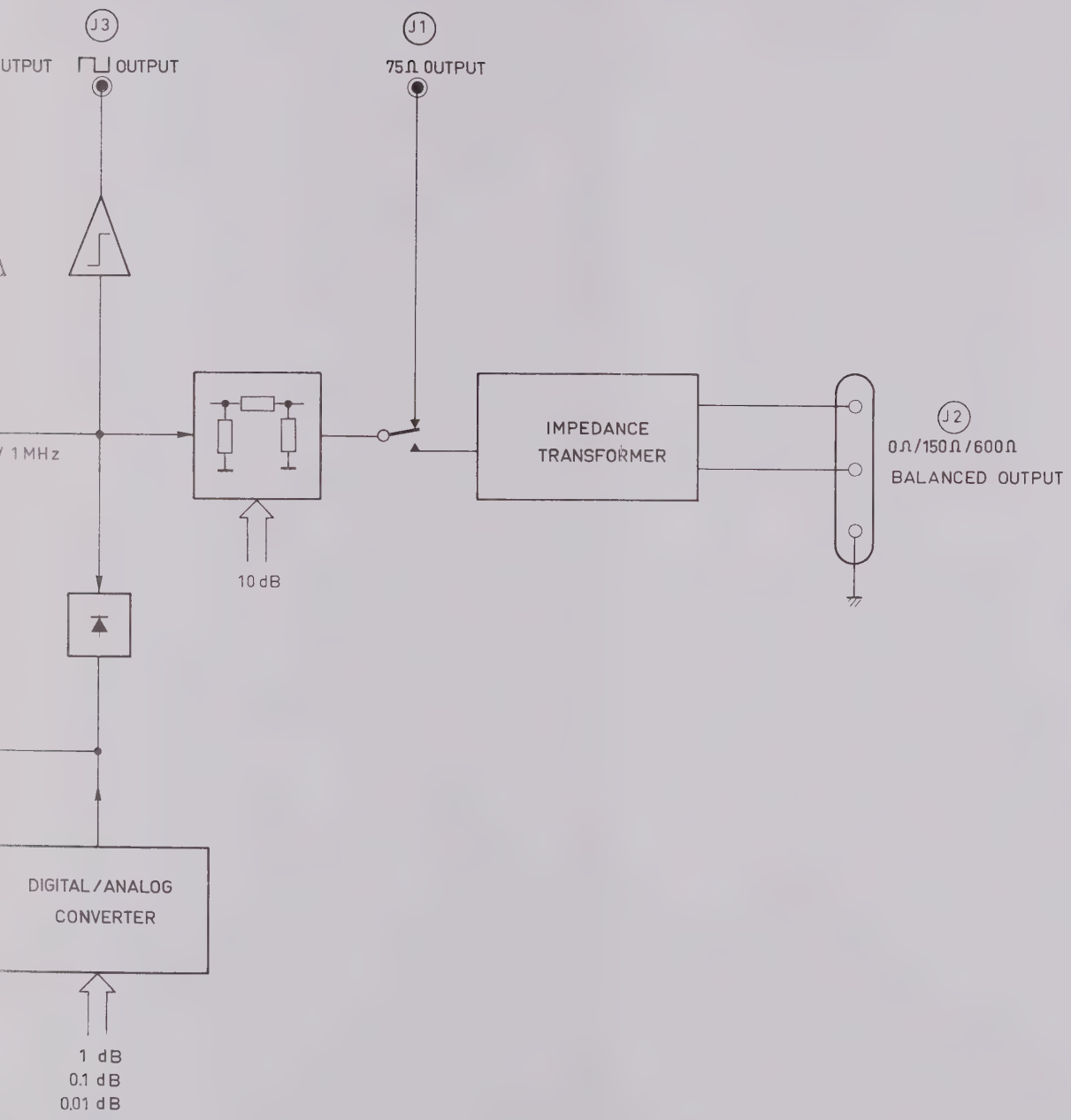


PLATE III-1

2230A - PRINCIPLE OF OPERATION

Lever/indicator switches for digital frequency setting.

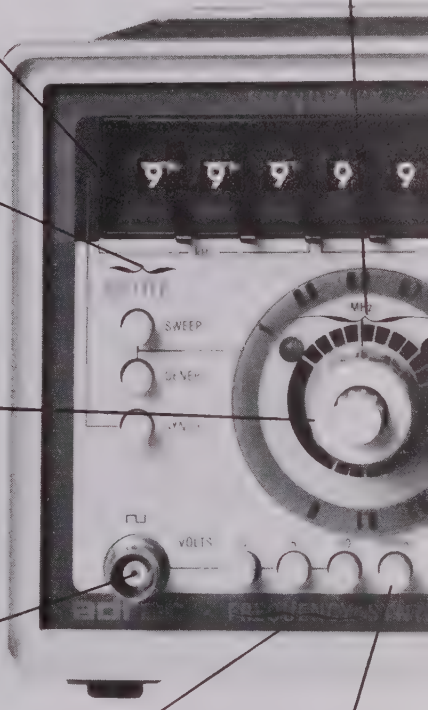
Indicator lights permitting to co
output frequency in Generator c
mode with the digital display of

K2

DS3

Mode selection of output frequency setting :
- Key **SYNTH.** pressed : digital setting by switches **K2.**
- Key **GENER.** pressed : analogical setting by verniers **P1.**
- Key **SWEEP.** pressed : analogical setting by verniers **P1** and sweep by external signal applied to connector **J7.**

K3



Analogical setting of output frequency in Generator or Sweeper mode.

P1

Square-wave output.
0V, 5V or 10V amplitude selected by keyboard **K7.**

J3

K7

K6

Selection of square-wave amplitude : 0V, 5V or 10V.

INHIB. key : permits to suppress the outpu
signal without switching off the instrument

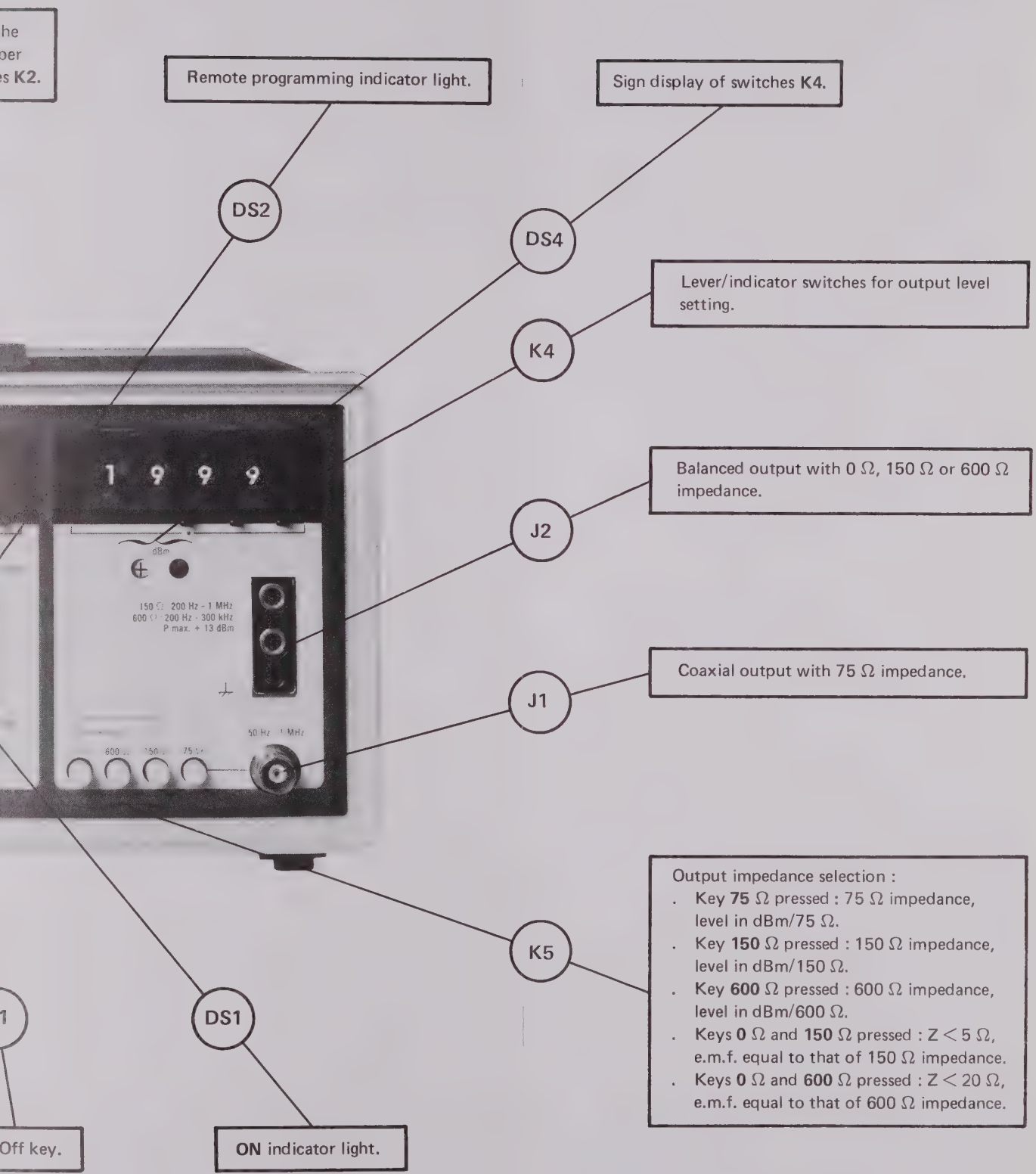
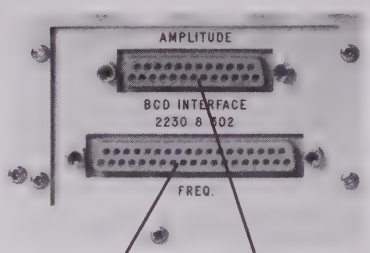

he
oer
s K2.
Remote programming indicator light.
Sign display of switches K4.
DS2
DS4
Lever/indicator switches for output level setting.
K4
1 9 9 9
Balanced output with 0 Ω, 150 Ω or 600 Ω impedance.
J2
Coaxial output with 75 Ω impedance.
J1
Output impedance selection :
. Key 75 Ω pressed : 75 Ω impedance, level in dBm/75 Ω.
. Key 150 Ω pressed : 150 Ω impedance, level in dBm/150 Ω.
. Key 600 Ω pressed : 600 Ω impedance, level in dBm/600 Ω.
. Keys 0 Ω and 150 Ω pressed : Z < 5 Ω, e.m.f. equal to that of 150 Ω impedance.
. Keys 0 Ω and 600 Ω pressed : Z < 20 Ω, e.m.f. equal to that of 600 Ω impedance.
K5
DS1
Off key.
ON indicator light.

PLATE IV-1

2230A - FRONT-PANEL DESCRIPTION

PARALLEL BCD PROGRAMMING
(Option 010)



S04

S03

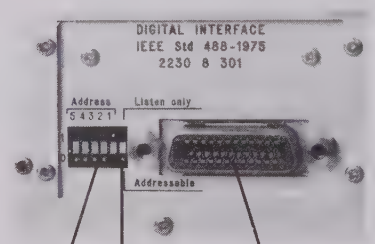
Output level programming connector

Output frequency programming connector

$Z < 1\Omega$ auxiliary output
Electromotive force variable from 0 dBm to +20 dBm/75Ω according to the main output level.

J8

IEEE BUS PROGRAMMING
(Option 020)



K10

K11

S05

Address selection switches

IEEE bus connector

Address enable switch

J6

Internal reference output.
Frequency : 1 MHz
Level : +6 dBm/50Ω

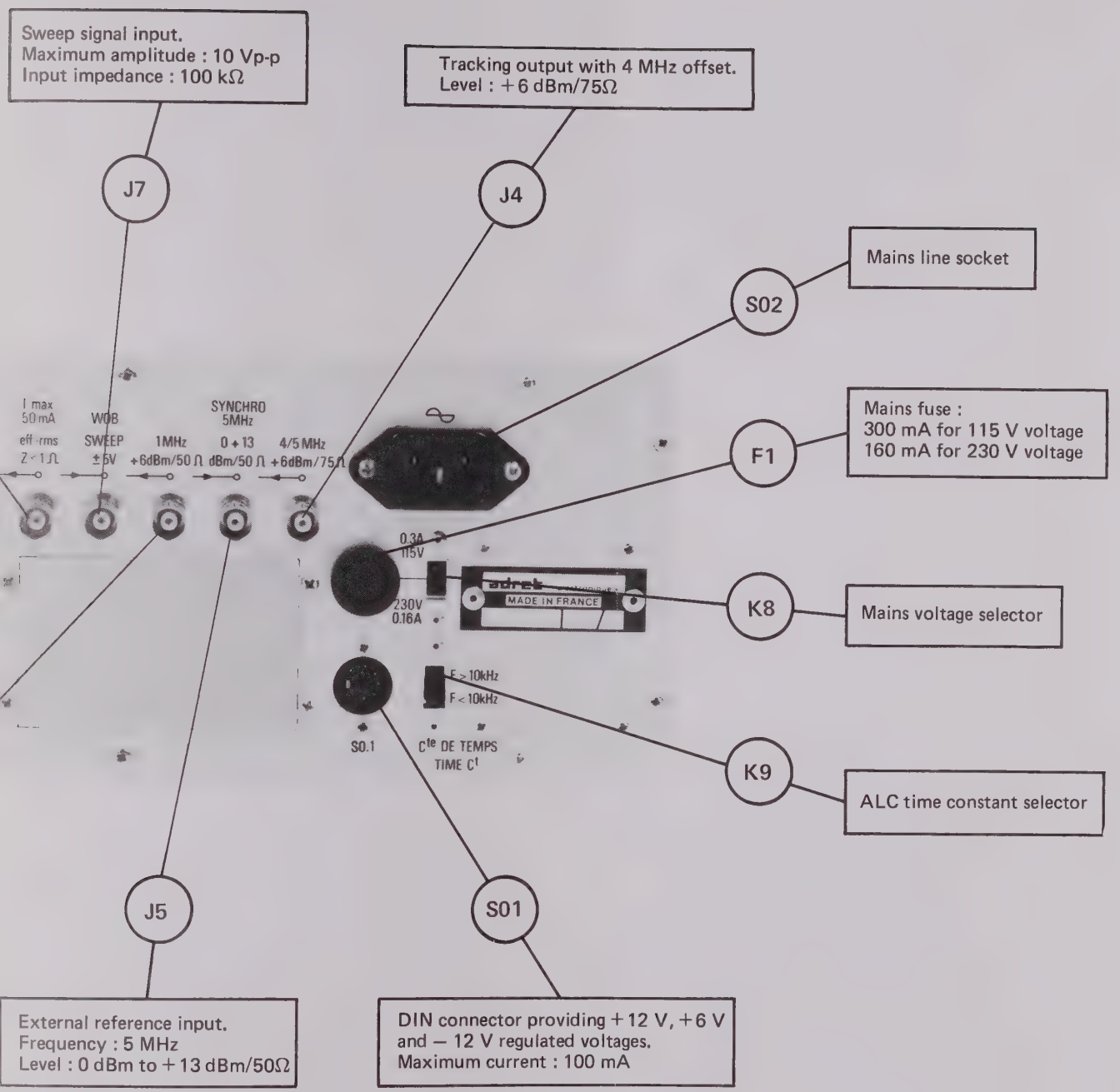


PLATE IV-2

2230A - REAR-PANEL DESCRIPTION

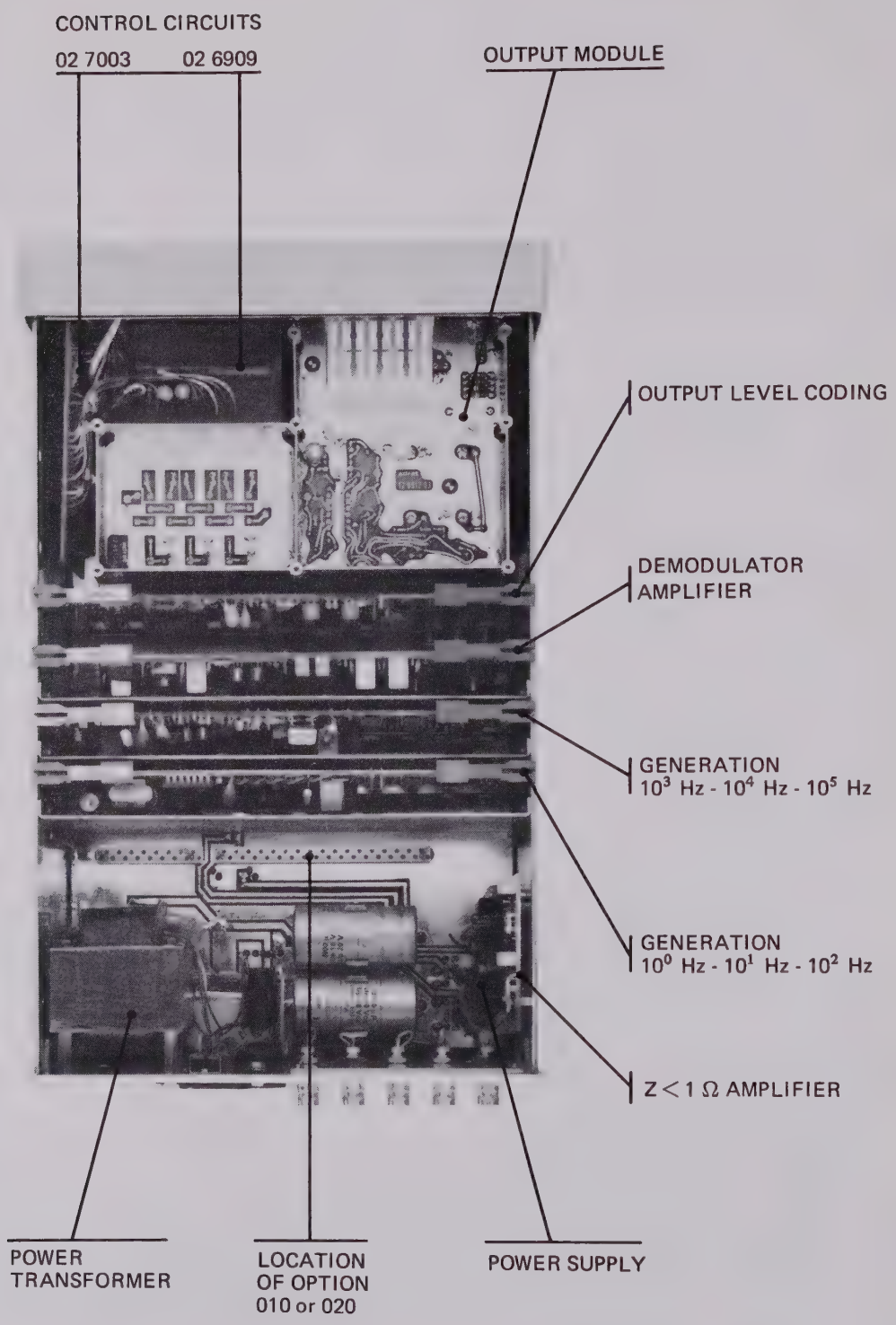
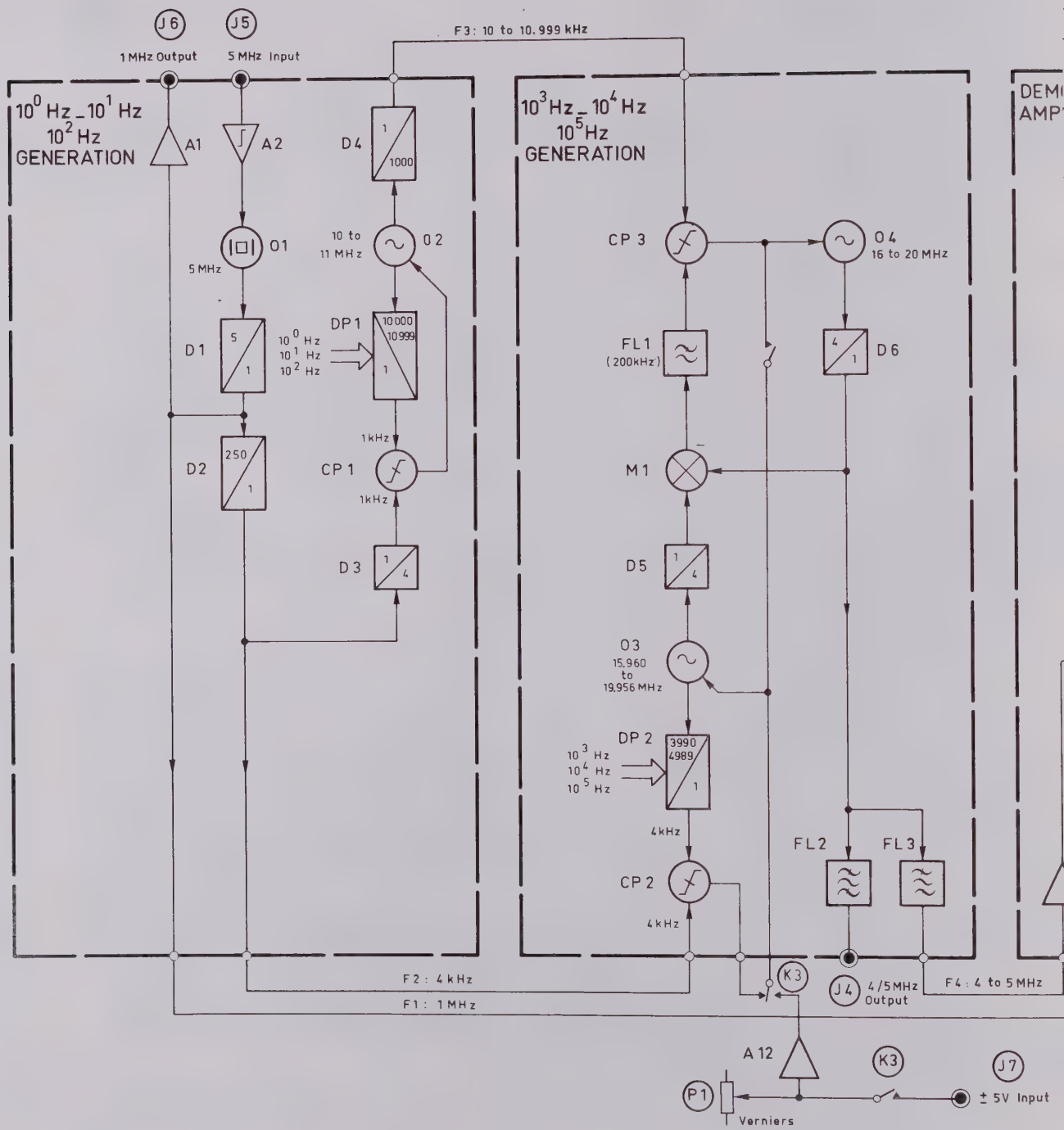


PLATE IV-3

2230A_INTERNAL DESCRIPTION


J6
1 MHz Output
J5
5 MHz Input
F3 : 10 to 10.999 kHz
10^0 Hz _ 10^1 Hz
10^2 Hz
GENERATION
A1
A2
D4
1
1000
10 to
11 MHz
O2
O1
5 MHz
D1
5
1
10^0 Hz
10^1 Hz
10^2 Hz
DP1
10000
10999
1
1kHz
D2
250
1
CP 1
1kHz
D3
1
4
10^3 Hz _ 10^4 Hz
10^5 Hz
GENERATION
CP 3
O4
16 to 20 MHz
FL1
(200kHz)
4
1
D6
M1
D5
1
4
O3
15.960
to
19.956 MHz
DP 2
3990
4989
1
10^3 Hz
10^4 Hz
10^5 Hz
4kHz
FL2
FL3
CP 2
4kHz
DEM
AMP
F2 : 4 kHz
F1 : 1 MHz
K3
J4
4/5MHz
Output
F4 : 4 to 5 MHz
A 12
K3
J7
P1
Verniers
± 5V Input

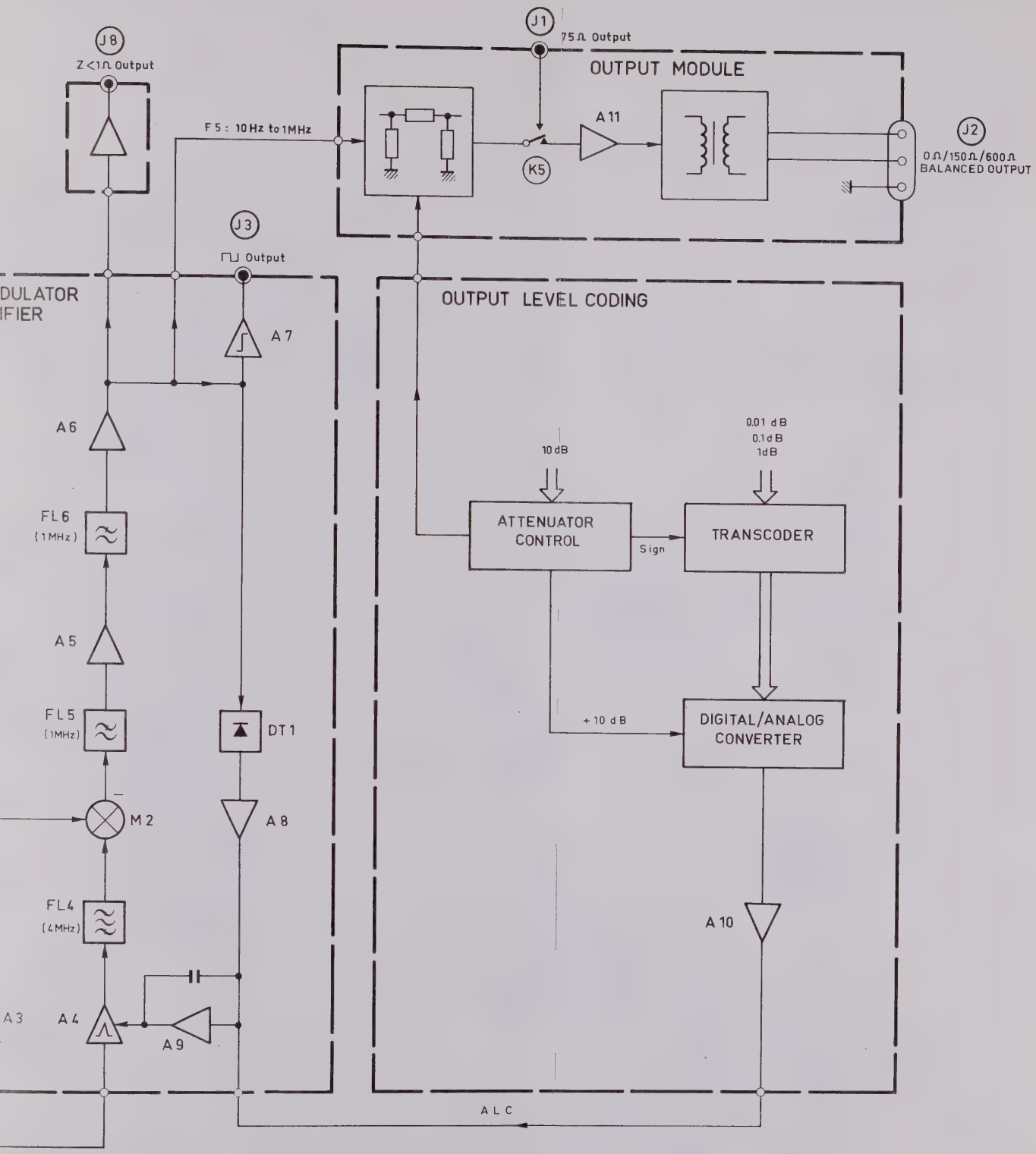
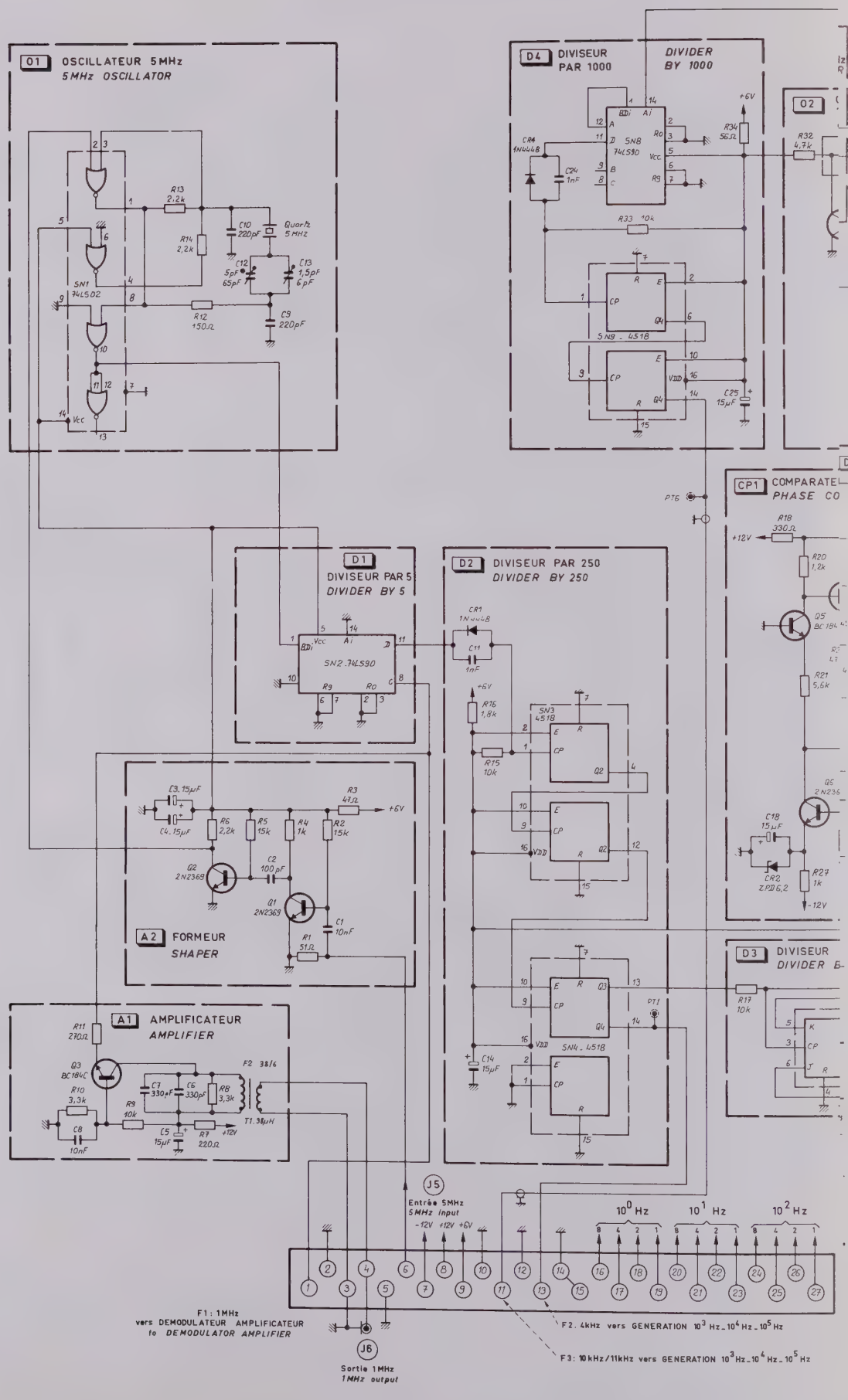
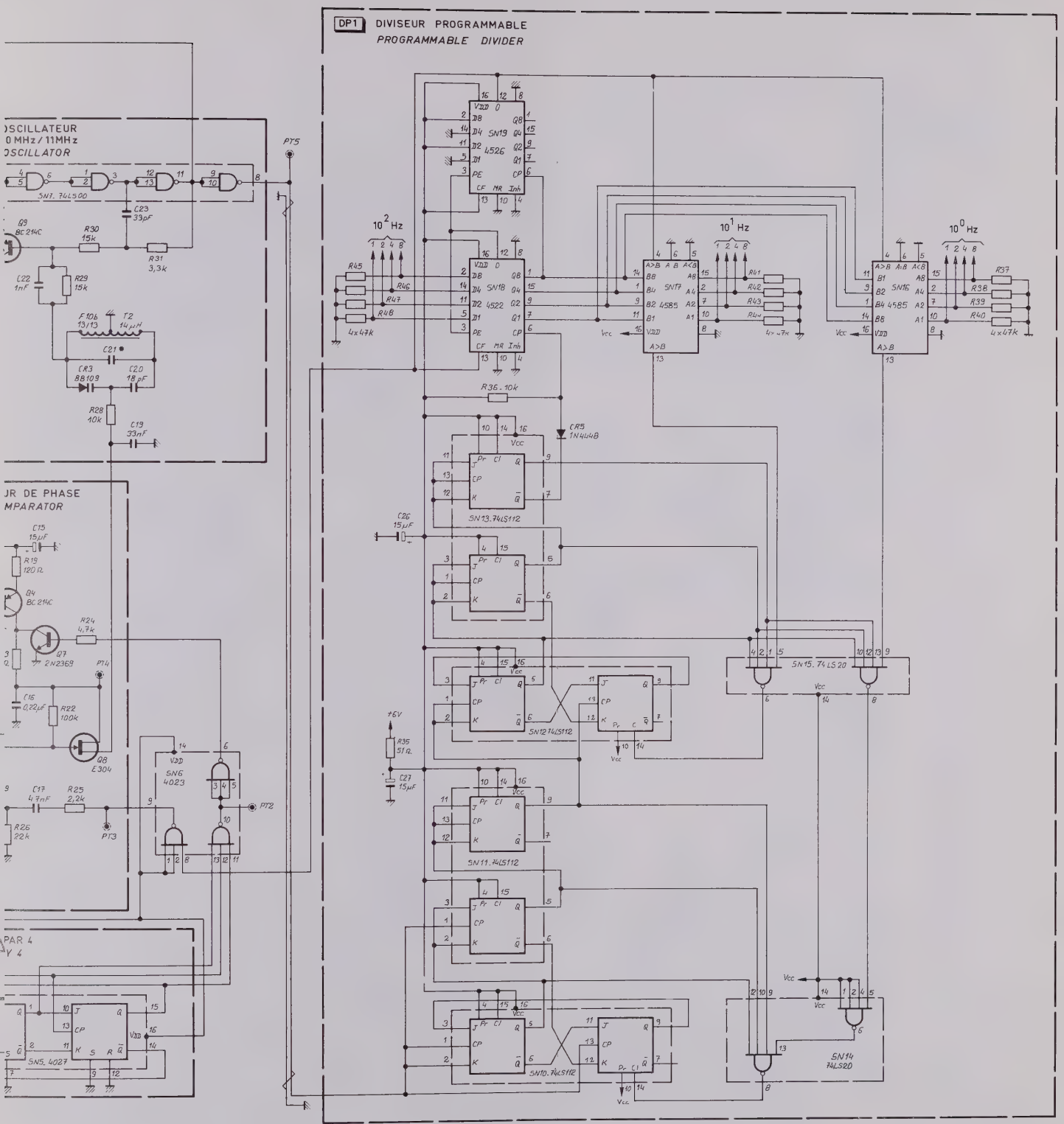


PLATE V_1

2230A_BLOCK DIAGRAM


O1 OSCILLATEUR 5MHz
5MHz OSCILLATOR
SN1 74LS02
R13 2,2k
R14 2,2k
C10 220pF
Quartz 5 MHz
C12 5pF 65pF
C13 1,5pF 6pF
R12 150Ω
C9 220pF
Vcc
D4 DIVISEUR PAR 1000
DIVIDER BY 1000
SN8 74LS90
CR4 1N4448
C24 1nF
R34 56Ω
+6V
R33 10k
SN9 - 4518
C25 15µF
O2
R32 4,7k
CP1 COMPARATEUR
PHASE CO
PT6
R18 330Ω
+12V
R20 1,2k
Q5 BC 184
R21 5,6k
Q6 2N2369
C18 15µF
CR2 ZPD 6,2
R27 1k
-12V
D1 DIVISEUR PAR 5
DIVIDER BY 5
SN2.74LS90
D2 DIVISEUR PAR 250
DIVIDER BY 250
CR1 1N4448
C11 1nF
R16 1,8k
R15 10k
SN3 4518
SN4 - 4518
C14 15µF
PT1
D3 DIVISEUR
DIVIDER B-
R17 10k
A2 FORMEUR
SHAPER
C3 15µF
C4 15µF
R6 2,2k
R5 15k
R4 1k
R2 15k
R3 47Ω
Q2 2N2369
C2 100pF
Q1 2N2369
C1 10nF
R1 51Ω
A1 AMPLIFICATEUR
AMPLIFIER
R11 270Ω
Q3 BC184C
R10 3,3k
C8 10nF
R9 10k
C7 330pF
C6 330pF
R8 3,3k
F2 38/6
T1 38µH
C5 15µF
R7 220Ω
+12V
J5
Entrée 5MHz
5MHz input
-12V +12V +6V
10^0 Hz
10^1 Hz
10^2 Hz
F1 : 1MHz
vers DEMODULATEUR AMPLIFICATEUR
to DEMODULATOR AMPLIFIER
J6
Sortie 1MHz
1MHz output
F2. 4kHz vers GENERATION 10^3 Hz_10^4 Hz_10^5 Hz
F3: 10kHz/11kHz vers GENERATION 10^3Hz_10^4 Hz_10^5 Hz



* Ajusté en fabrication
Factory adjusted

PLATE V_2
PLANCHE V_2

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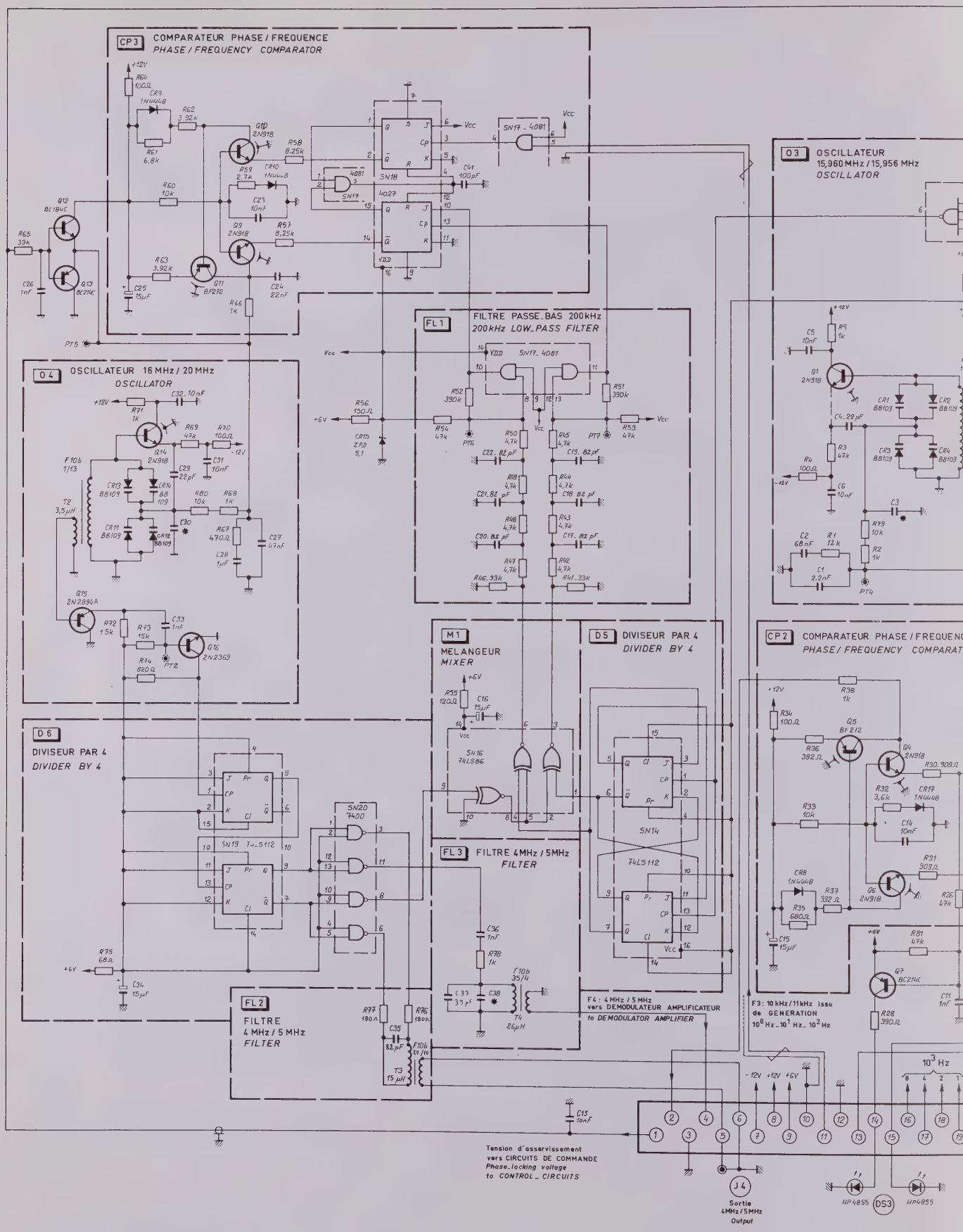
ÉTUDIÉ	DESSINÉ	VÉRIFIÉ	2230 A	PAGE : 1 / 1
	ACORT	HV	GÉNÉRATION 10^0 Hz_10^1 Hz_10^2 Hz	976905


CP3 COMPARATEUR PHASE / FREQUENCE
PHASE / FREQUENCY COMPARATOR
O3 OSCILLATEUR
15,960 MHz / 15,956 MHz
OSCILLATOR
FL1 FILTRE PASSE_BAS 200 kHz
200 kHz LOW_PASS FILTER
O4 OSCILLATEUR 16 MHz / 20 MHz
OSCILLATOR
M1 MELANGEUR
MIXER
D5 DIVISEUR PAR 4
DIVIDER BY 4
CP2 COMPARATEUR PHASE / FREQUENC
PHASE / FREQUENCY COMPARAT
D6 DIVISEUR PAR 4
DIVIDER BY 4
FL3 FILTRE 4 MHz / 5 MHz
FILTER
FL2 FILTRE
4 MHz / 5 MHz
FILTER
F4 : 4 MHz / 5 MHz
vers DEMODULATEUR AMPLIFICATEUR
to DEMODULATOR AMPLIFIER
F3 : 10 kHz / 11 kHz issu
de GENERATION
10^0 Hz_10^1 Hz_10^2 Hz
10^3 Hz
Tension d'asservissement
vers CIRCUITS DE COMMANDE
Phase_locking voltage
to CONTROL_CIRCUITS
Sortie
4 MHz / 5 MHz
Output
HP4855
DS3
HP4855

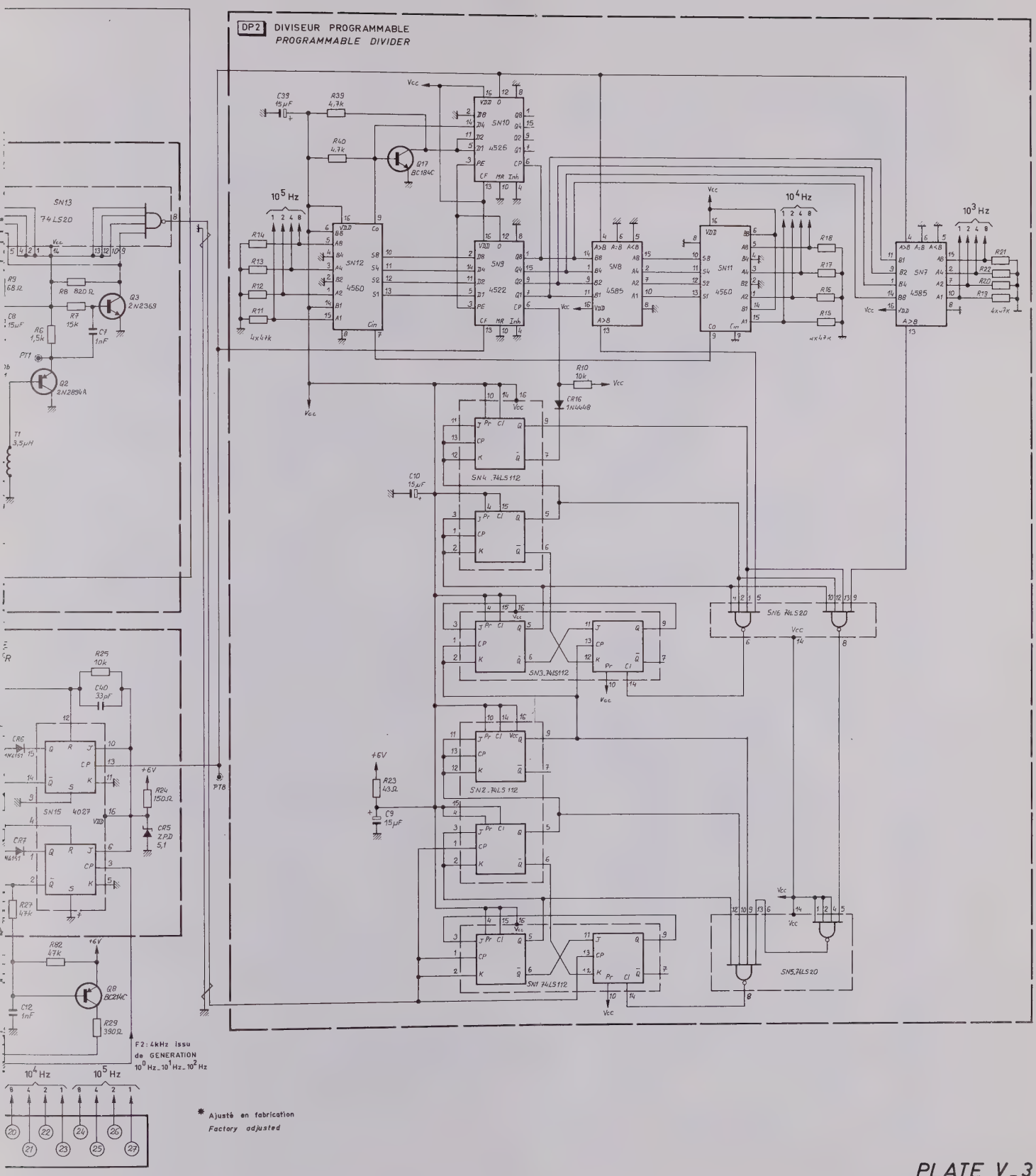


PLATE V_3
PLANCHE V_3

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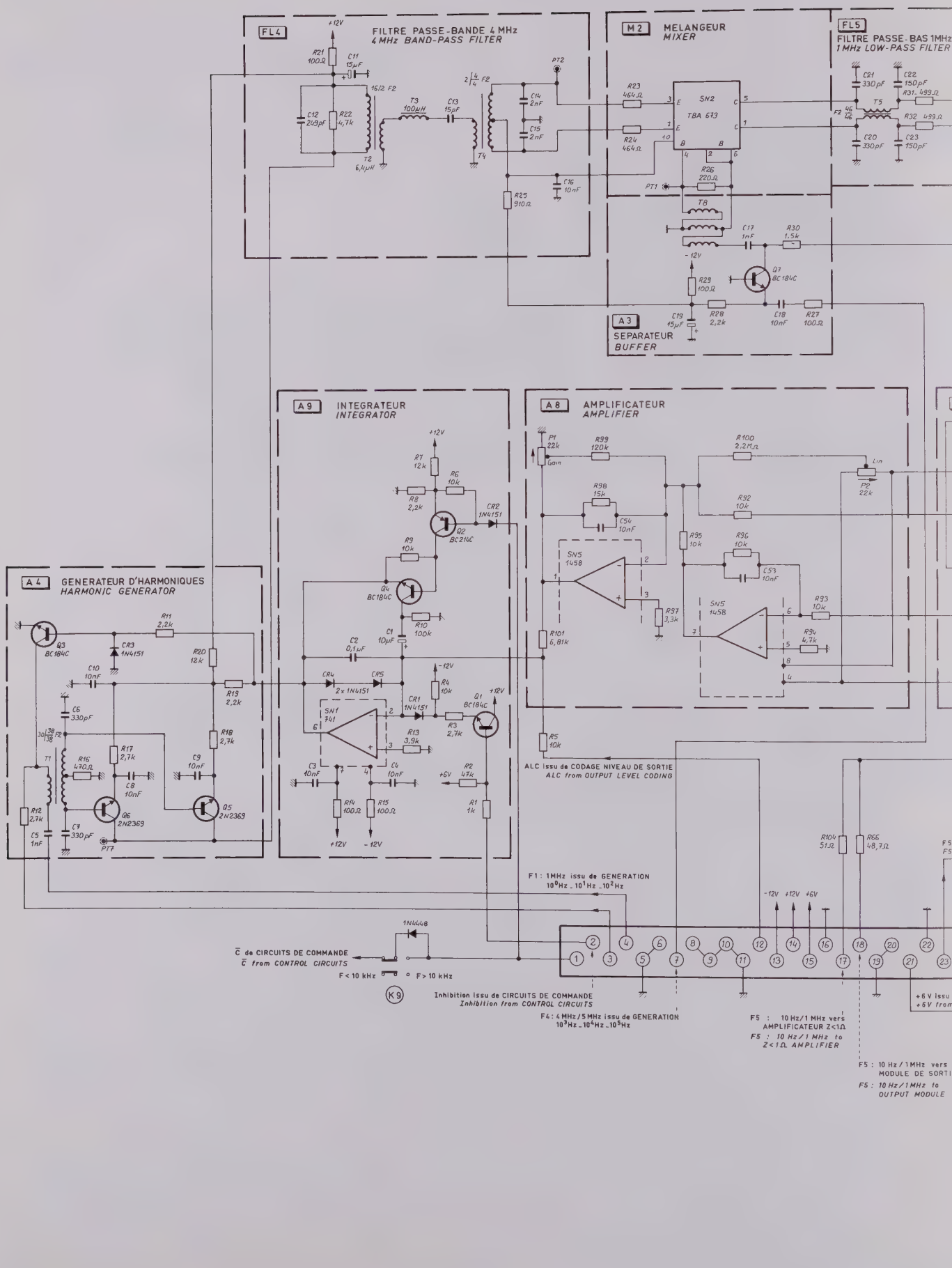
ÉTUDIÉ	DESSINÉ	VÉRIFIÉ
	ACORT	HK

2230 A
GENERATION 10^3 Hz_10^4 Hz_10^5 Hz

DATE : JUILLET 1978

PAGE : 1 / 1

976906


FL4
FILTRE PASSE-BANDE 4 MHz
4 MHz BAND-PASS FILTER
M2
MELANGEUR
MIXER
FL5
FILTRE PASSE-BAS 1MHz
1 MHz LOW-PASS FILTER
A3
SEPARATEUR
BUFFER
A9
INTEGRATEUR
INTEGRATOR
A8
AMPLIFICATEUR
AMPLIFIER
A4
GENERATEUR D'HARMONIQUES
HARMONIC GENERATOR
+12V
-12V
+6V
SN2
TBA 673
SN5
1458
ALC issu de CODAGE NIVEAU DE SORTIE
ALC from OUTPUT LEVEL CODING
F1 : 1MHz issu de GENERATION
10^0Hz _ 10^1Hz _ 10^2Hz
F4 : 4 MHz / 5 MHz issu de GENERATION
10^3Hz _ 10^4Hz _ 10^5Hz
C de CIRCUITS DE COMMANDE
C from CONTROL CIRCUITS
F < 10 kHz
F > 10 kHz
K9
Inhibition issu de CIRCUITS DE COMMANDE
Inhibition from CONTROL CIRCUITS
F5 : 10 Hz/1 MHz vers AMPLIFICATEUR Z<1Ω
F5 : 10 Hz / 1 MHz to Z<1Ω AMPLIFIER
F5 : 10 Hz / 1MHz vers MODULE DE SORTI
F5 : 10 Hz / 1MHz to OUTPUT MODULE
+6V issu
+6V from

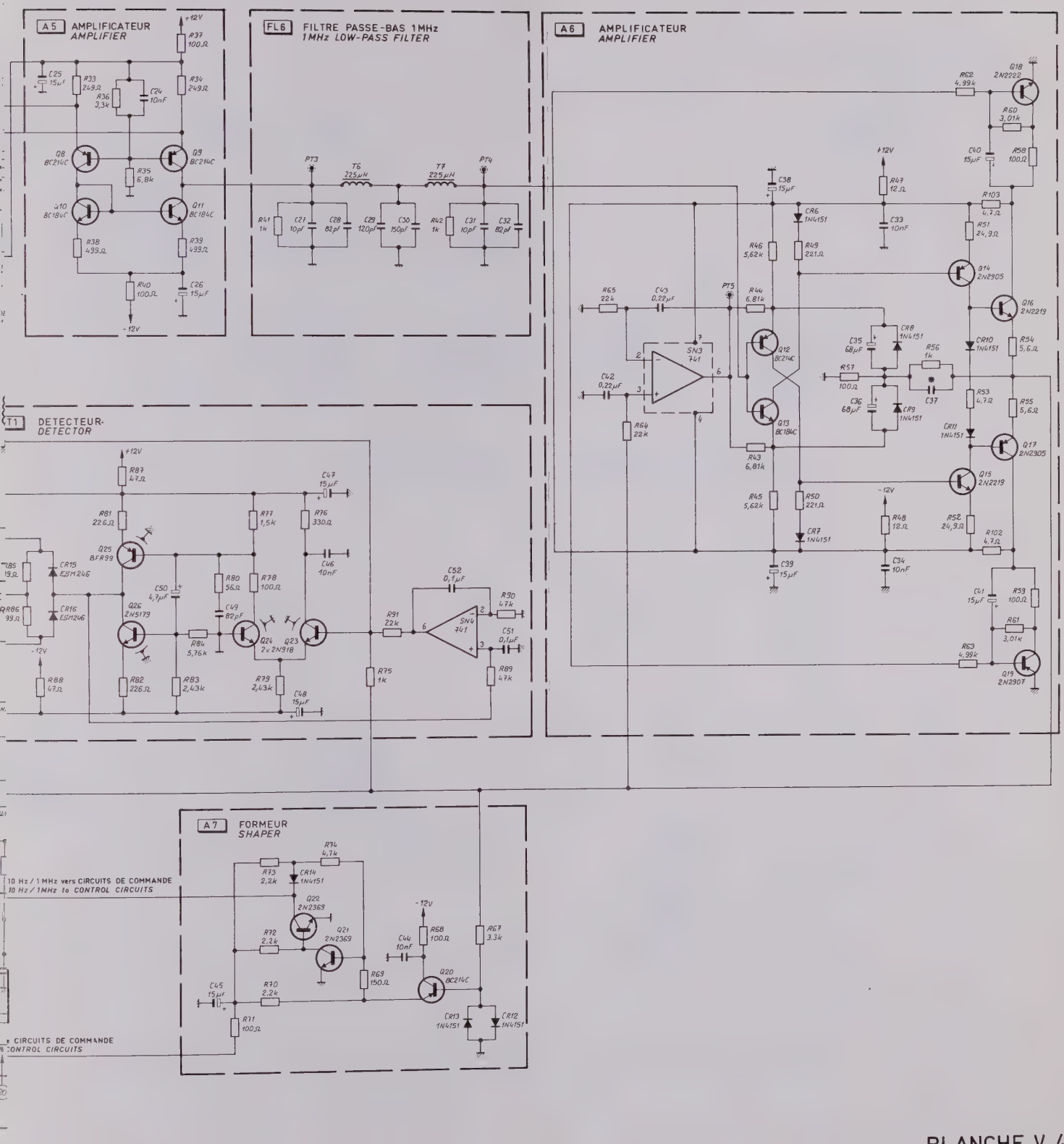


PLANCHE V_4
PLATE V_4

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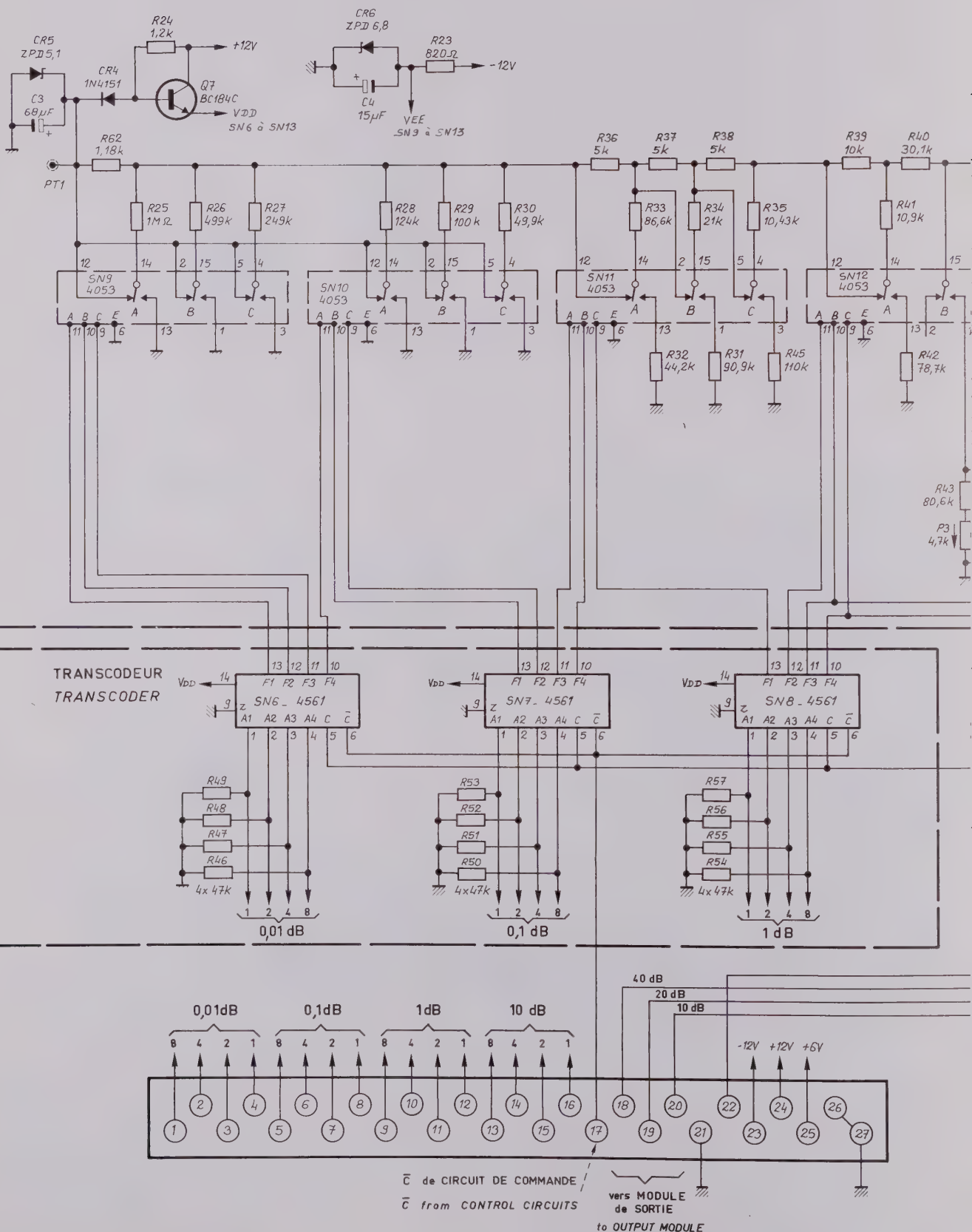
ÉTUDIE	DESSINÉ	VÉRIFIÉ	2230 A		PAGE : 1 / 1
	ACORT	H.V.	DEMODULATEUR AMPLIFICATEUR *DEMODULATOR AMPLIFIER*		9 7 6 9 0 7

CONVERTISSEUR NUMERIQUE / ANALOGIQUE
DIGITAL / ANALOG CONVERTER



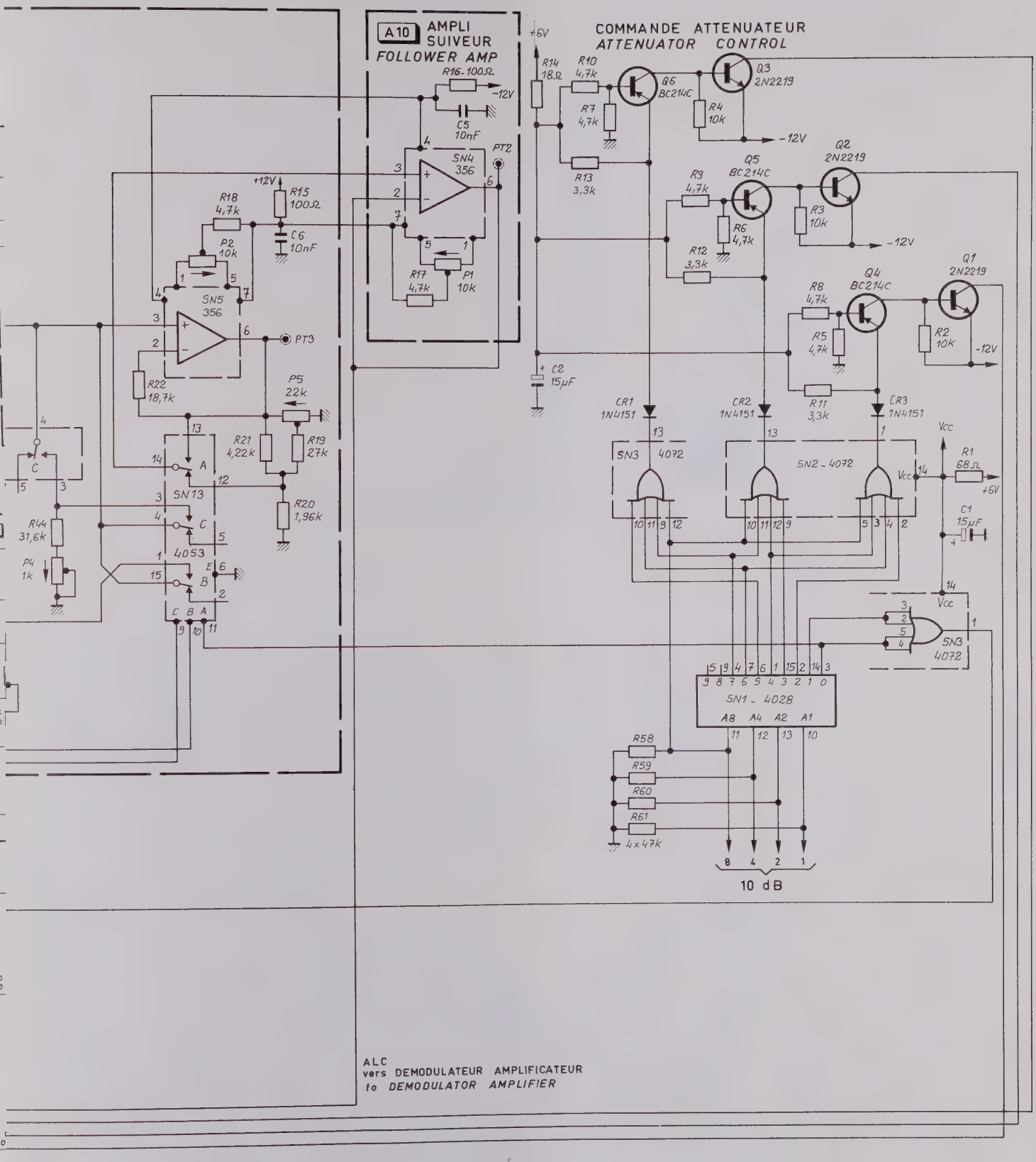


PLATE V_5
PLANCHE V_5

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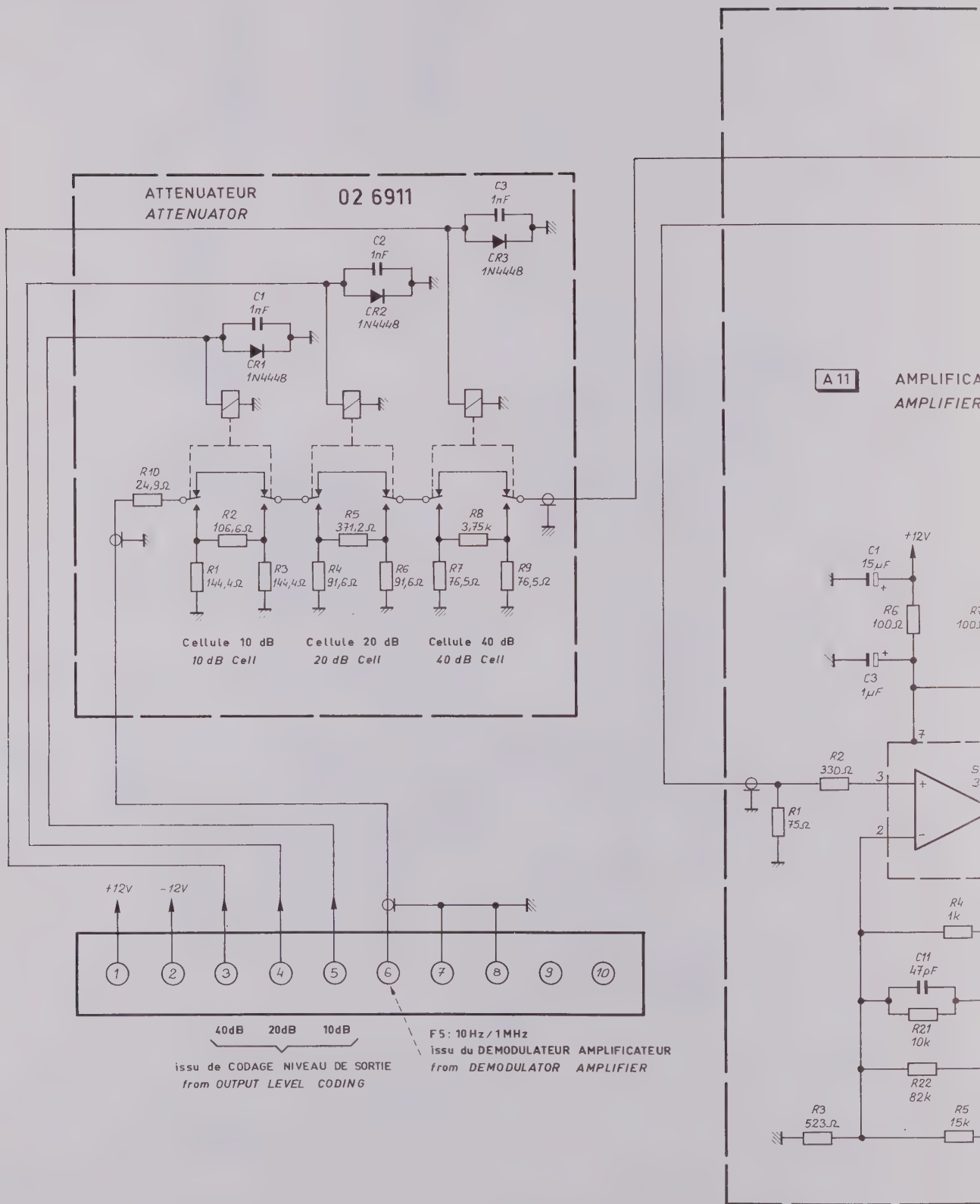
			adret electronique	DATE : JUILLET 1978
ÉTUDIÉ	DESSINÉ	VÉRIFIÉ	2230 A	PAGE : 1 / 1
	ACORT	HV	CODAGE NIVEAU DE SORTIE *OUTPUT LEVEL CODING*	976908


ATTENUATEUR
ATTENUATOR
02 6911
C3
1nF
CR3
1N4448
C2
1nF
CR2
1N4448
C1
1nF
CR1
1N4448
R10
24,9Ω
R2
106,6Ω
R5
371,2Ω
R8
3,75k
R1
144,4Ω
R3
144,4Ω
R4
91,6Ω
R6
91,6Ω
R7
76,5Ω
R9
76,5Ω
Cellule 10 dB
10 dB Cell
Cellule 20 dB
20 dB Cell
Cellule 40 dB
40 dB Cell
A 11
AMPLIFICA
AMPLIFIER
+12V
C1
15µF
R6
100Ω
C3
1µF
R2
330Ω
R1
75Ω
R4
1k
C11
47pF
R21
10k
R22
82k
R3
523Ω
R5
15k
+12V
-12V
1
2
3
4
5
6
7
8
9
10
40dB
20dB
10dB
issu de CODAGE NIVEAU DE SORTIE
from OUTPUT LEVEL CODING
F5: 10Hz/1MHz
issu du DEMODULATEUR AMPLIFICATEUR
from DEMODULATOR AMPLIFIER

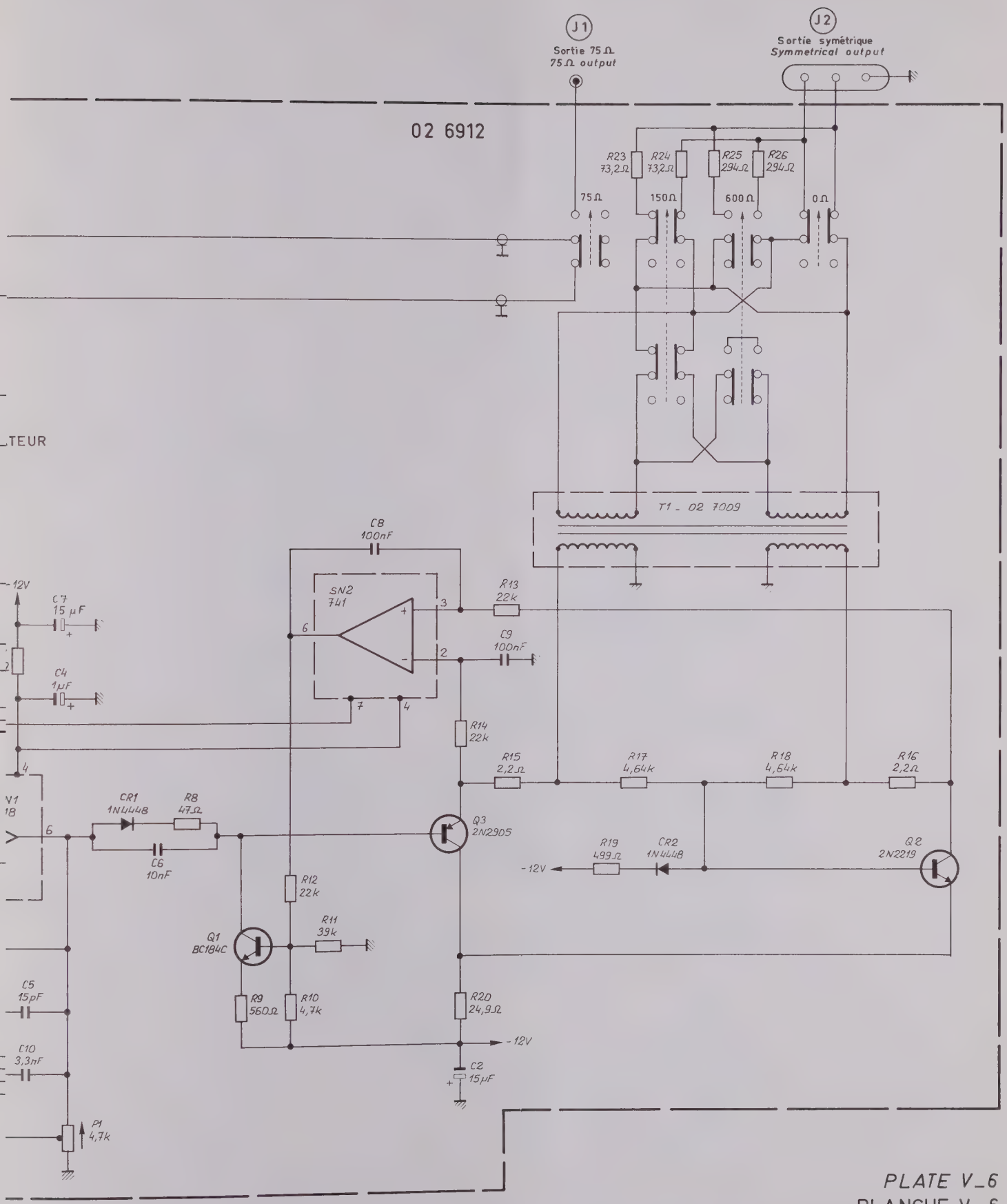


PLATE V_6
PLANCHE V_6

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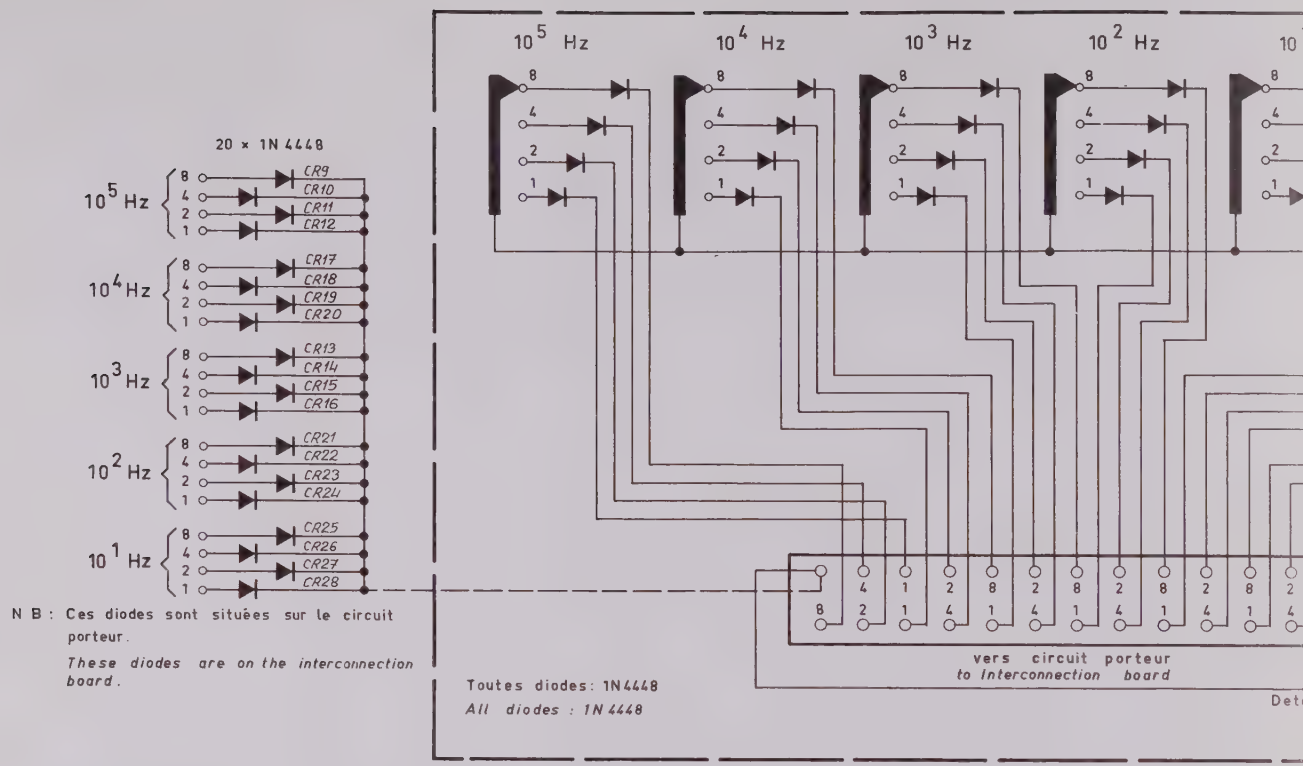
ÉTUDIÉ	DESSINÉ	VÉRIFIÉ
	ACORT	HA

2230 A
MODULE DE SORTIE
OUTPUT MODULE

DATE : JUILLET 1978

PAGE : 1 / 1

97691 0

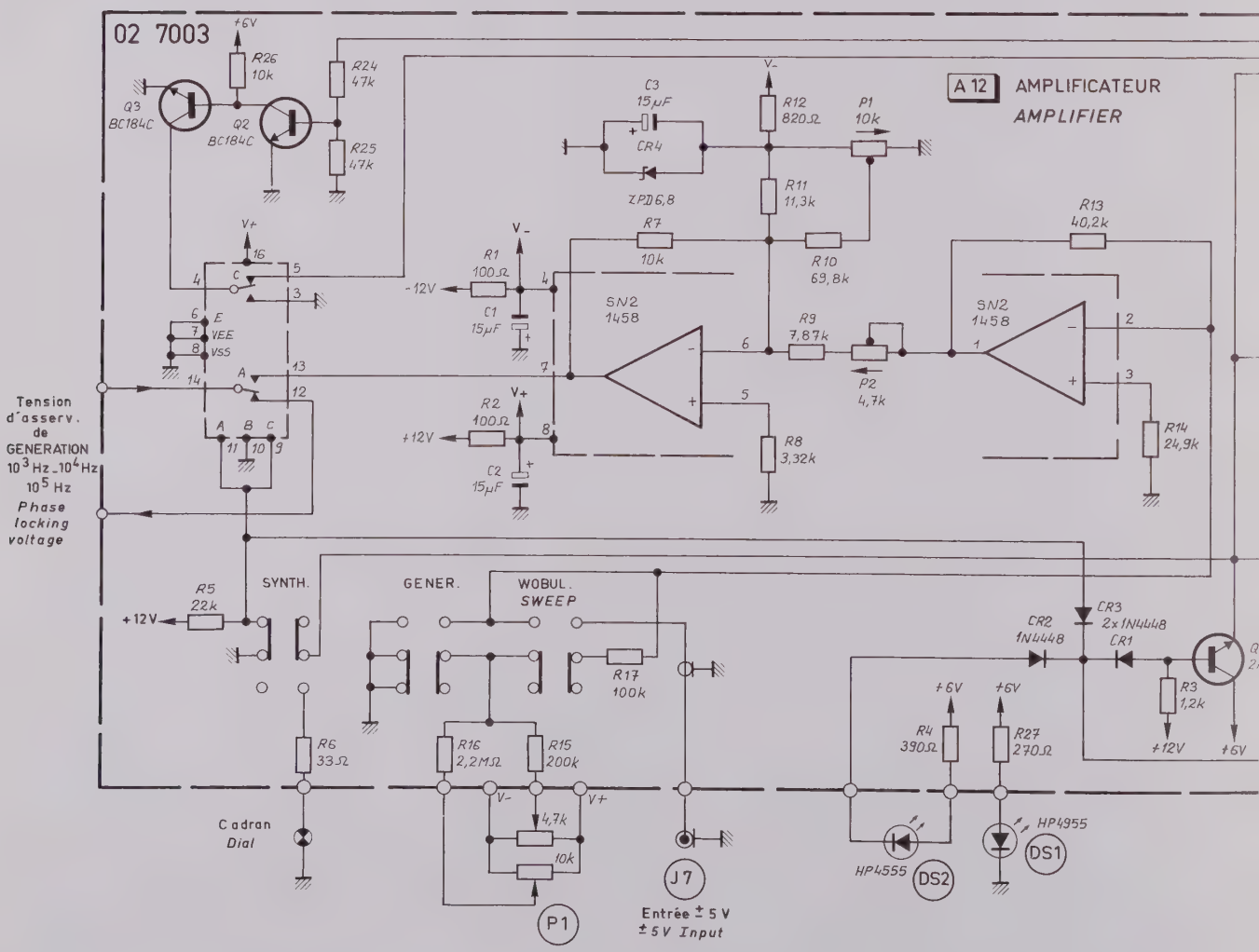


N B : Ces diodes sont situées sur le circuit porteur.

These diodes are on the interconnection board.

Toutes diodes: 1N4448

All diodes : 1N 4448



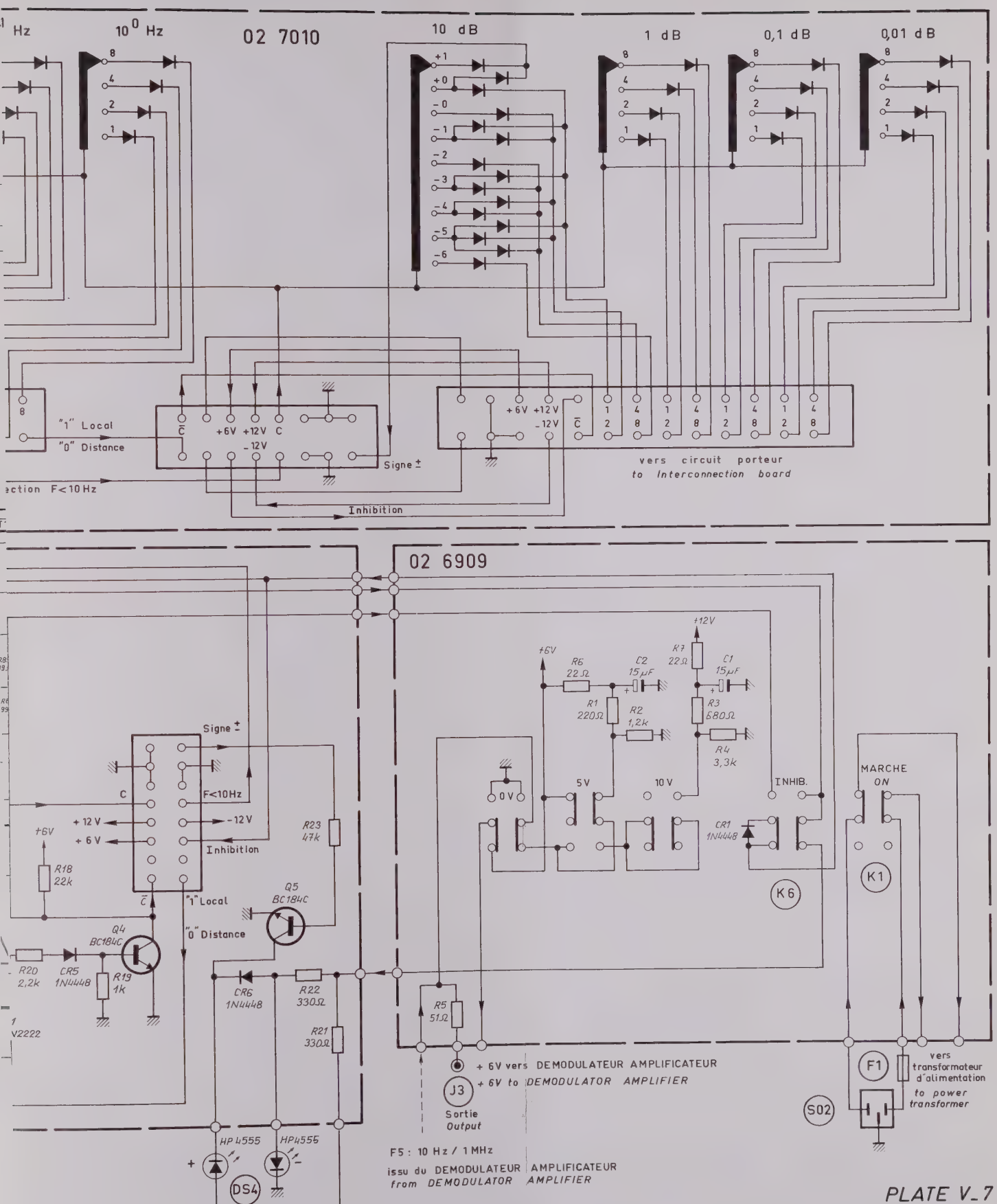


PLATE V_7
PLANCHE V_7

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ÉTUDIÉ	DESSINÉ	VÉRIFIÉ
	ACORT	H.K.

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2230 A
CIRCUITS DE COMMANDE
CONTROL CIRCUITS

DATE : JUILLET 1978

PAGE : 1 / 1

97703

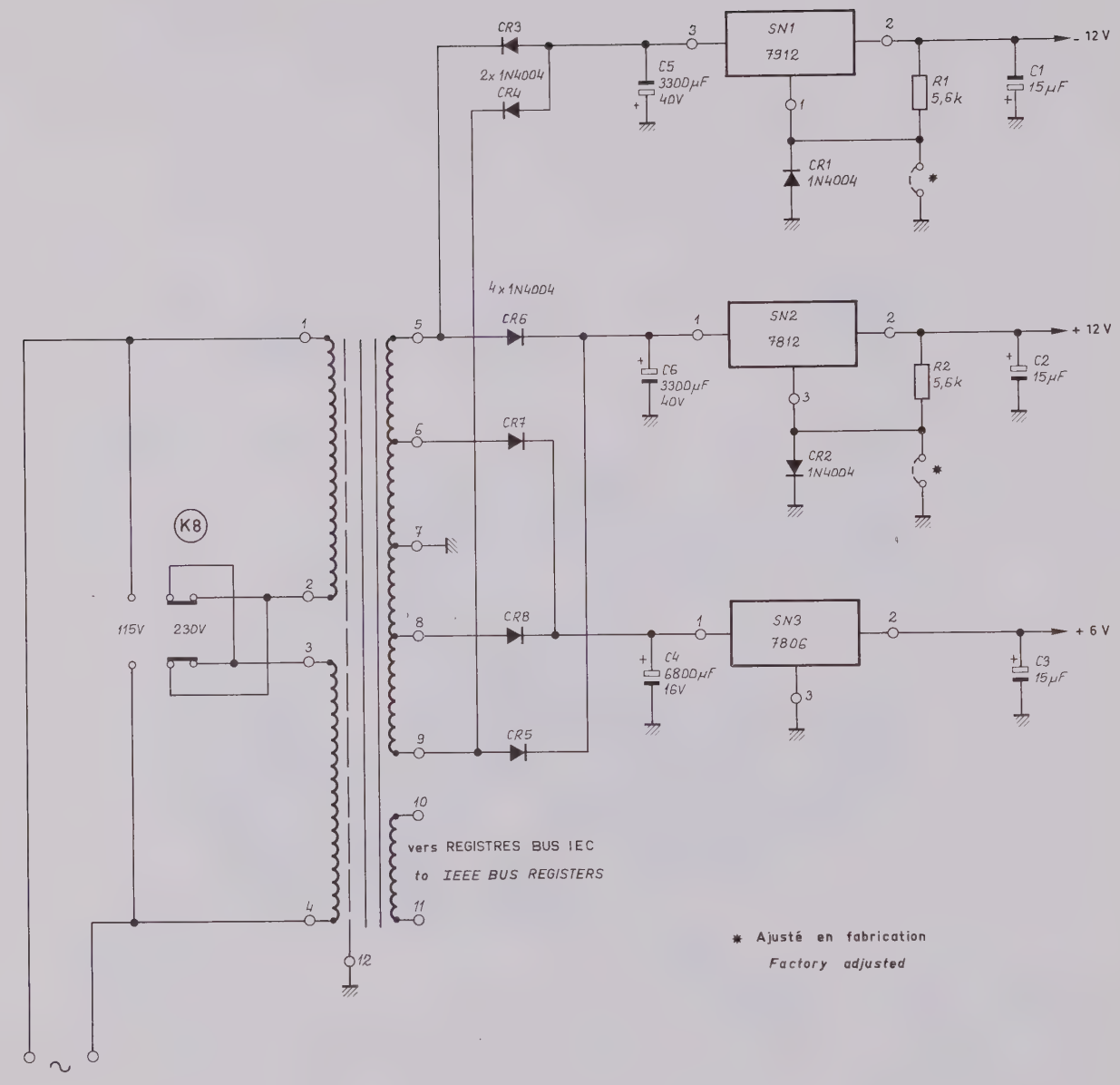

PLATE V-8

PLANCHE V-8

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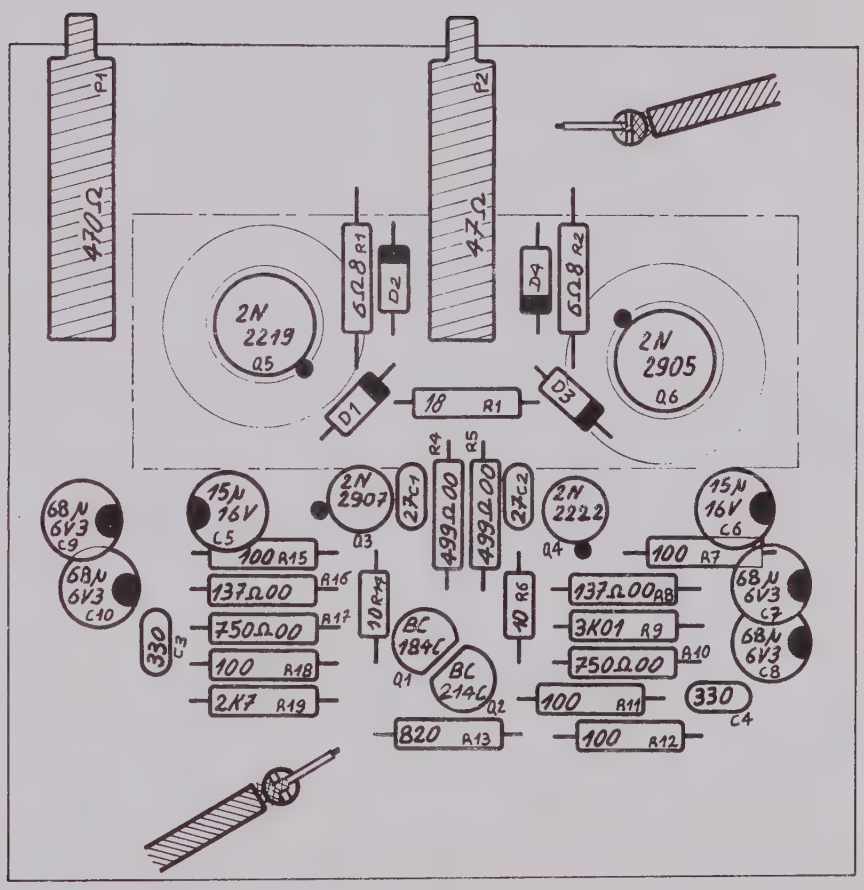
ÉTUDIÉ	DESSINÉ	VÉRIFIÉ
	ACORT	

2230 A
ALIMENTATION
POWER SUPPLY

PAGE : 1 / 1

976915


P1
470Ω
P2
47Ω
5Ω8 R1
D2
D4
5Ω8 R2
2N 2219 Q5
2N 2905 Q6
D1
18 R1
D3
R4
R5
15N 16V C5
2N 2907 Q3
27c1
499Ω00
499Ω00
27c2
2N 2222 Q4
15N 16V C6
68N 6V3 C9
68N 6V3 C10
100 R15
137Ω00 R16
750Ω00 R17
100 R18
2K7 R19
10 R14
R6
10
137Ω00 R8
3K01 R9
750Ω00 R10
100 R7
68N 6V3 C7
68N 6V3 C8
330 C3
BC 184C Q1
BC 214C Q2
100 R11
330 C4
820 R13
100 R12

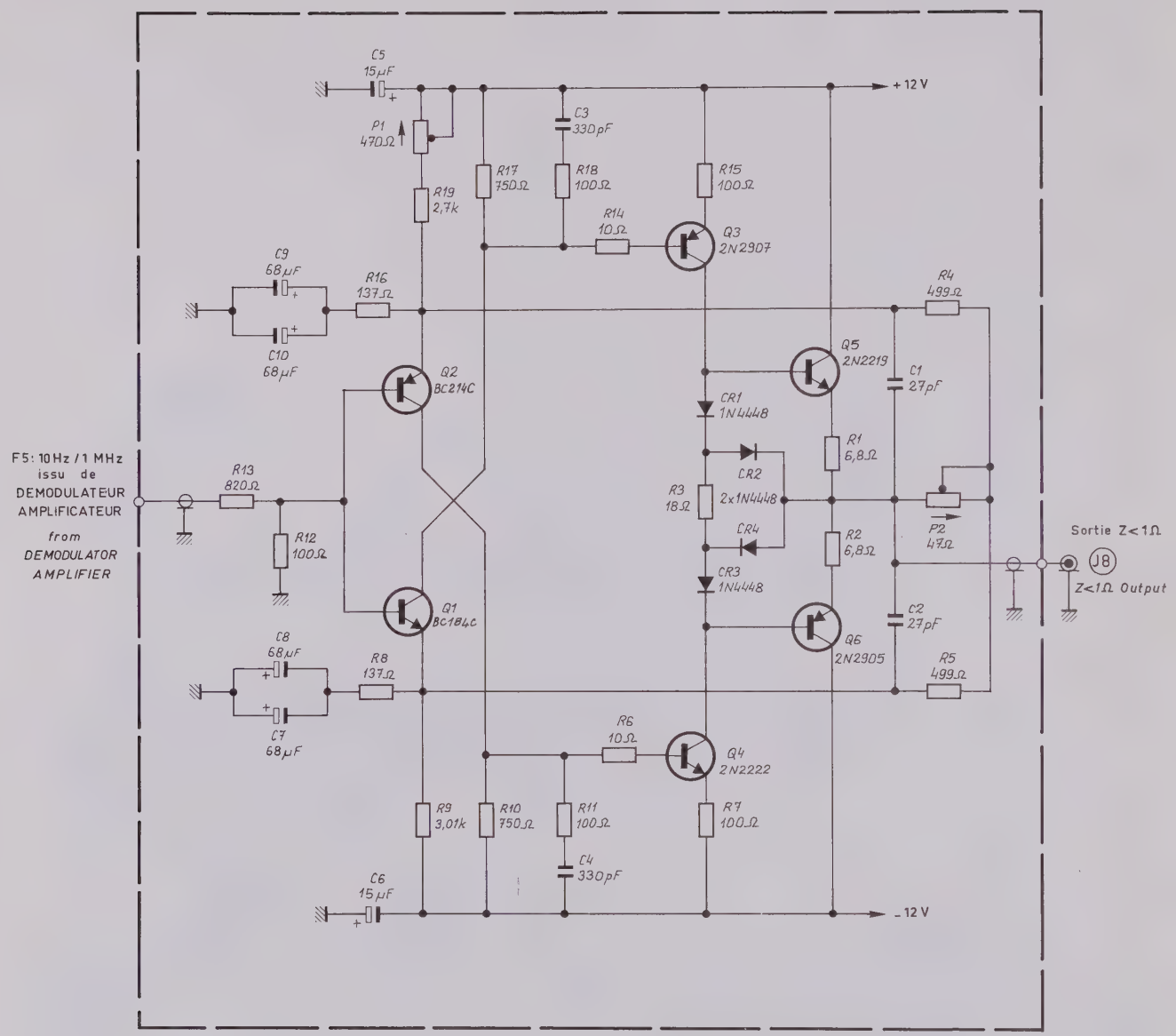


PLATE V-9

PLANCHE V-9

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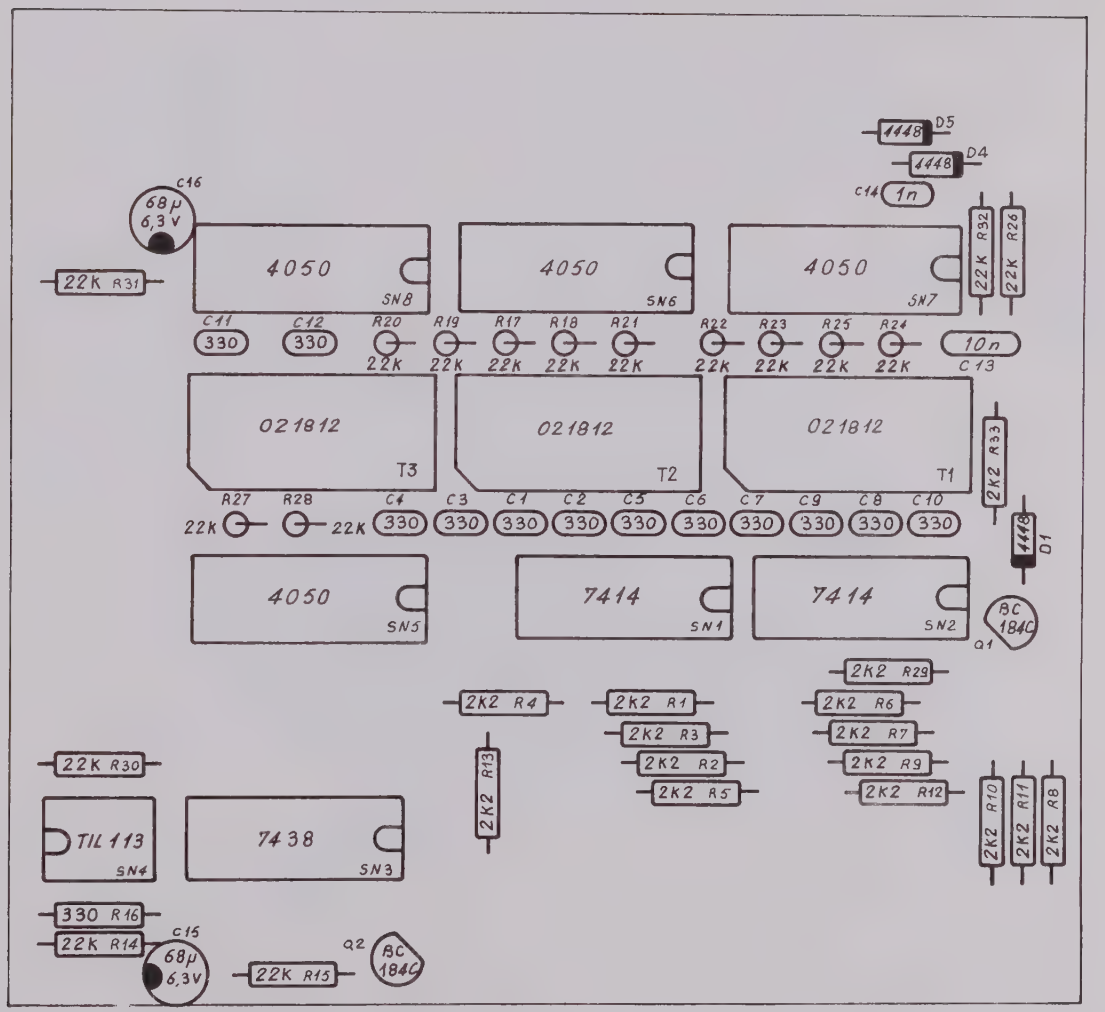
ÉTUDIÉ	DESSINÉ	VÉRIFIÉ
	ACORT	H.V.

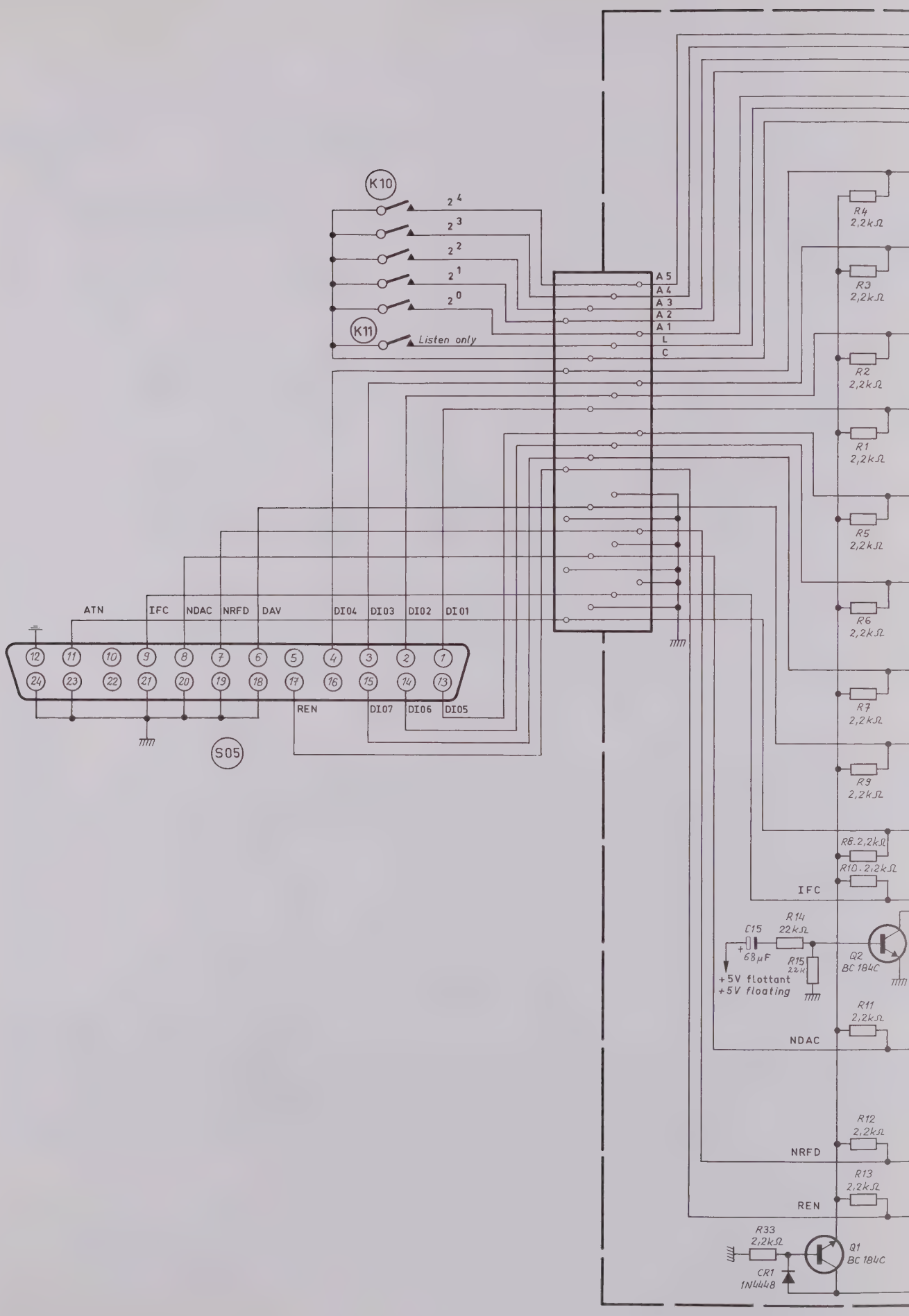
2230 A
AMPLIFICATEUR Z<1Ω
Z<1Ω AMPLIFIER

DATE : JUILLET 1978

PAGE : 1 / 1

9 7 7 0 9 4


1148 D5
1148 D4
C14 1n
C16 68µ 6,3 V
22K R31
4050 SN8
4050 SN6
4050 SN7
22K R32
22K R26
C11 330
C12 330
R20 22K
R19 22K
R17 22K
R18 22K
R21 22K
R22 22K
R23 22K
R25 22K
R24 22K
10n C13
021812 T3
021812 T2
021812 T1
2K2 R33
R27 22K
R28 22K
C4 330
C3 330
C1 330
C2 330
C5 330
C6 330
C7 330
C9 330
C8 330
C10 330
1148 D1
4050 SN5
7414 SN1
7414 SN2
BC 184C Q1
2K2 R29
2K2 R4
2K2 R1
2K2 R6
2K2 R3
2K2 R7
2K2 R13
2K2 R2
2K2 R9
2K2 R5
2K2 R12
2K2 R10
2K2 R11
2K2 R8
22K R30
TIL 113 SN4
7438 SN3
330 R16
22K R14
C15 68µ 6,3V
22K R15
Q2 BC 184C


K10
2 4
2 3
2 2
2 1
2 0
K11
Listen only
A 5
A 4
A 3
A 2
A 1
L
C
ATN
IFC
NDAC
NRFD
DAV
DI04
DI03
DI02
DI01
12 11 10 9 8 7 6 5 4 3 2 1
24 23 22 21 20 19 18 17 16 15 14 13
REN
DI07
DI06
DI05
S05
R4 2,2kΩ
R3 2,2kΩ
R2 2,2kΩ
R1 2,2kΩ
R5 2,2kΩ
R6 2,2kΩ
R7 2,2kΩ
R9 2,2kΩ
R8. 2,2kΩ
R10. 2,2kΩ
IFC
R14 22kΩ
C15 68µF
R15 22k
+5V flottant
+5V floating
Q2 BC 184C
R11 2,2kΩ
NDAC
R12 2,2kΩ
NRFD
R13 2,2kΩ
REN
R33 2,2kΩ
CR1 1N4448
Q1 BC 184C

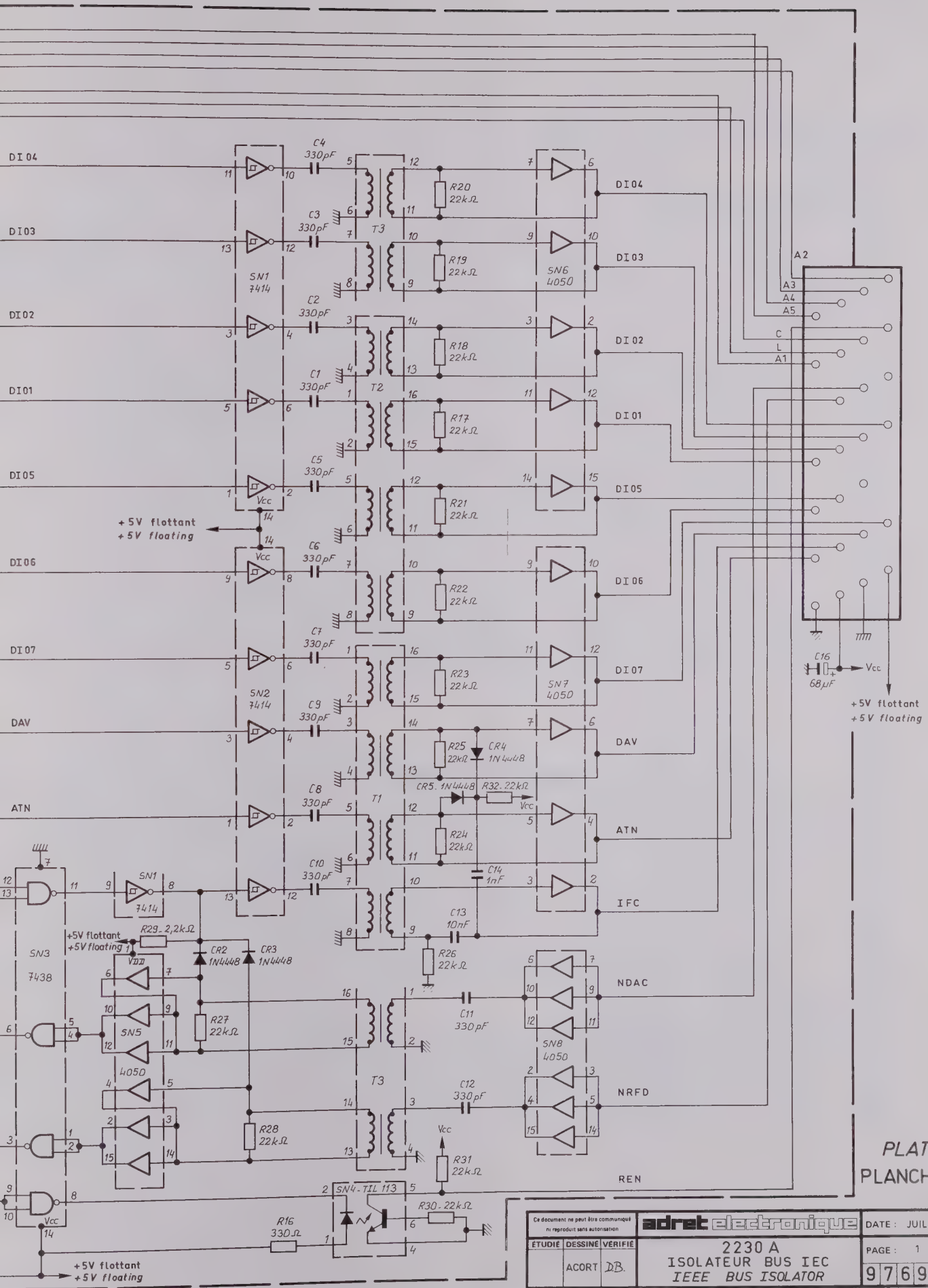


PLATE V_10
PLANCHE V_10

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ÉTUDIÉ	DESSINÉ	VÉRIFIÉ
	ACORT	DB.

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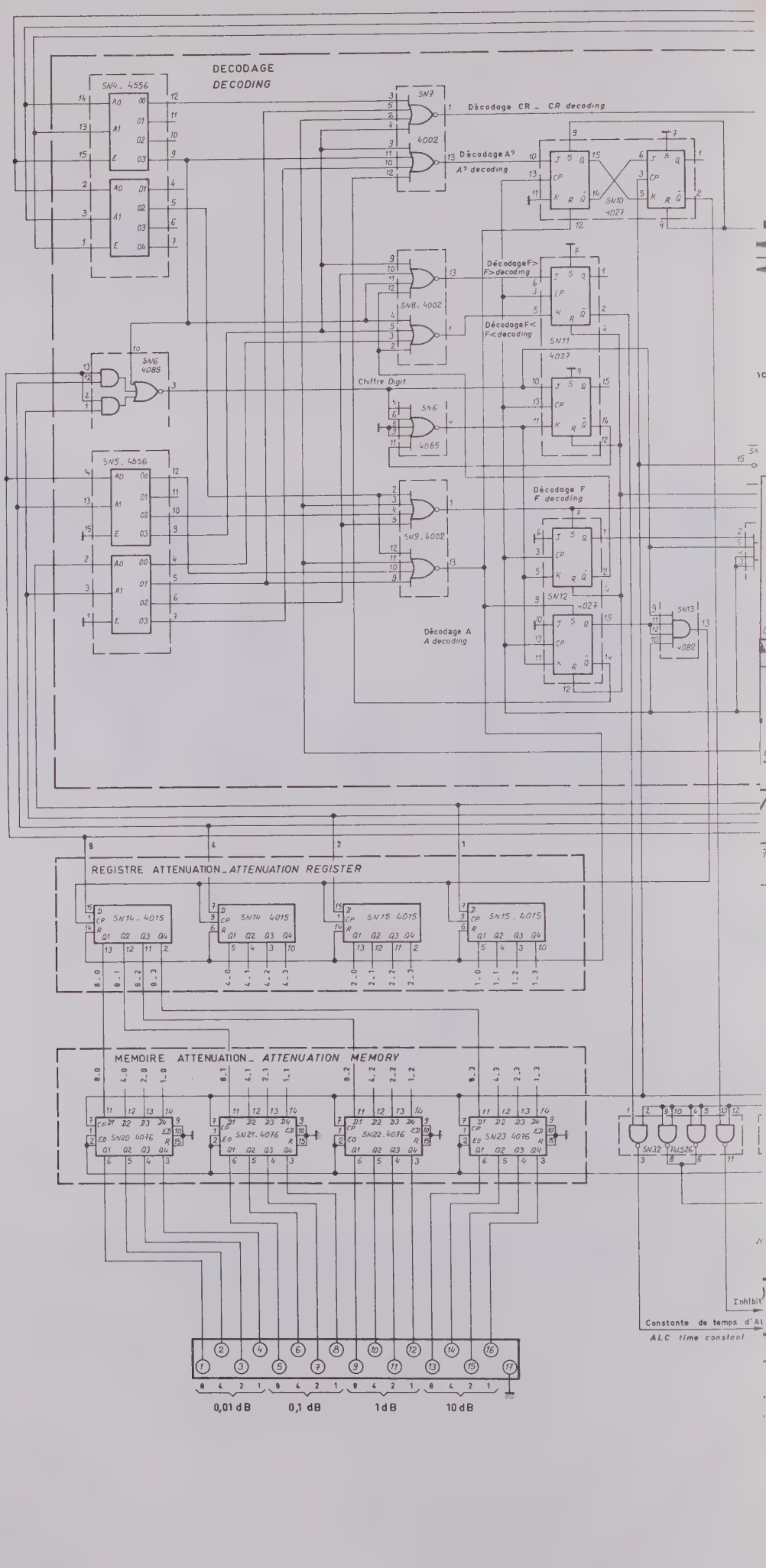
2230 A
ISOLATEUR BUS IEC
IEEE BUS ISOLATOR

PAGE : 1 / 1

9 7 6 9 9 8


DECODAGE
DECODING
SN4 . 4556
SN5 . 4556
SN6 4085
SN7 4002
SN8 . 4002
SN9 . 4002
Décodage CR _ CR decoding
Décodage A?
A? decoding
SN10 4027
Décodage F>
F> decoding
Décodage F<
F< decoding
SN11 4027
Chiffre Digit
SN6 4085
Décodage F
F decoding
SN12 4027
SN13 4082
Décodage A
A decoding
REGISTRE ATTENUATION _ ATTENUATION REGISTER
SN14 . 4015
SN15 . 4015
MEMOIRE ATTENUATION _ ATTENUATION MEMORY
SN20 4076
SN21 . 4076
SN22 . 4076
SN23 4076
SN32 74LS26
Inhibit
Constante de temps d'Al
ALC time constant
0,01 dB
0,1 dB
1 dB
10 dB

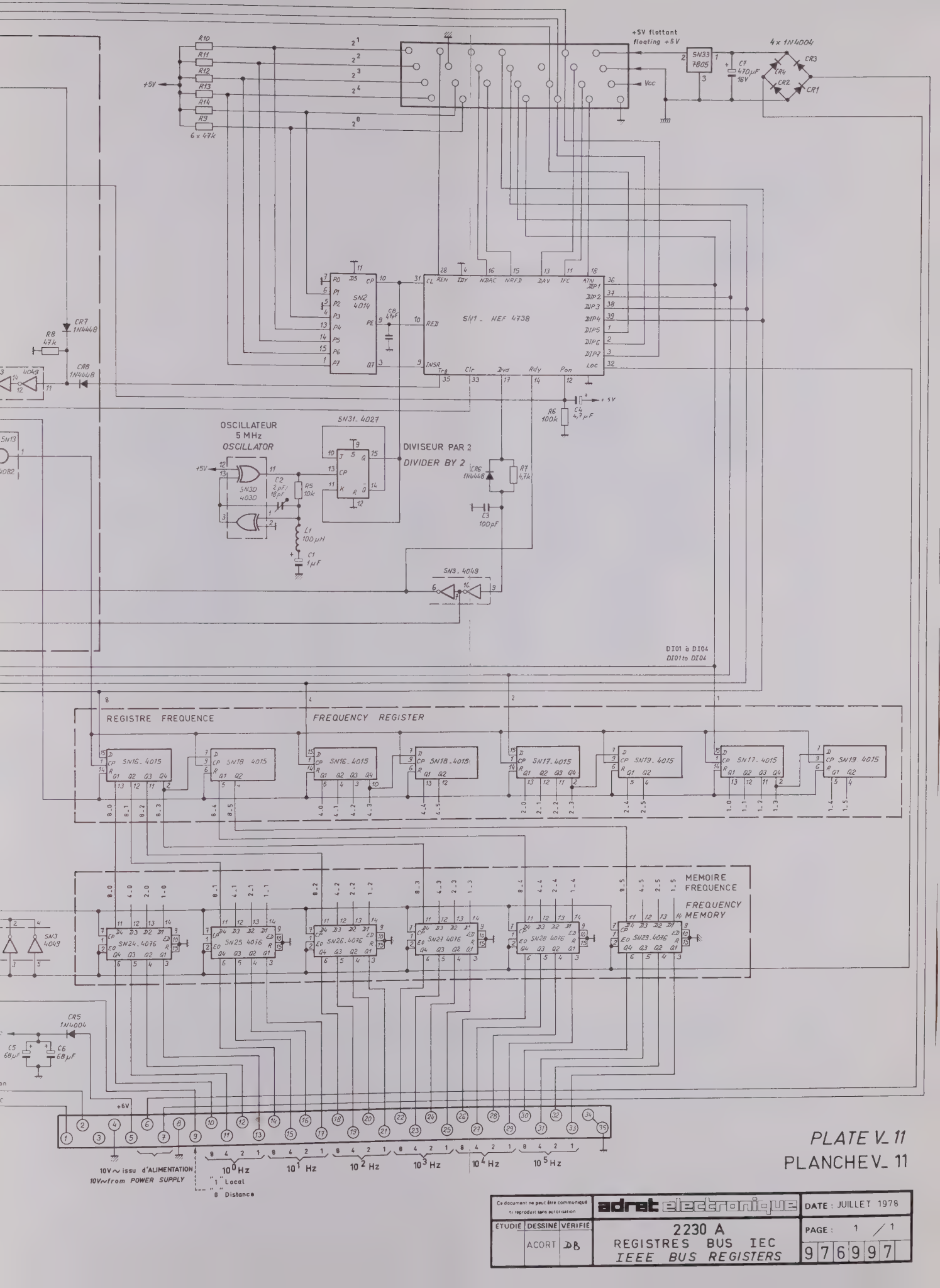


PLATE V_11

PLANCHE V_11

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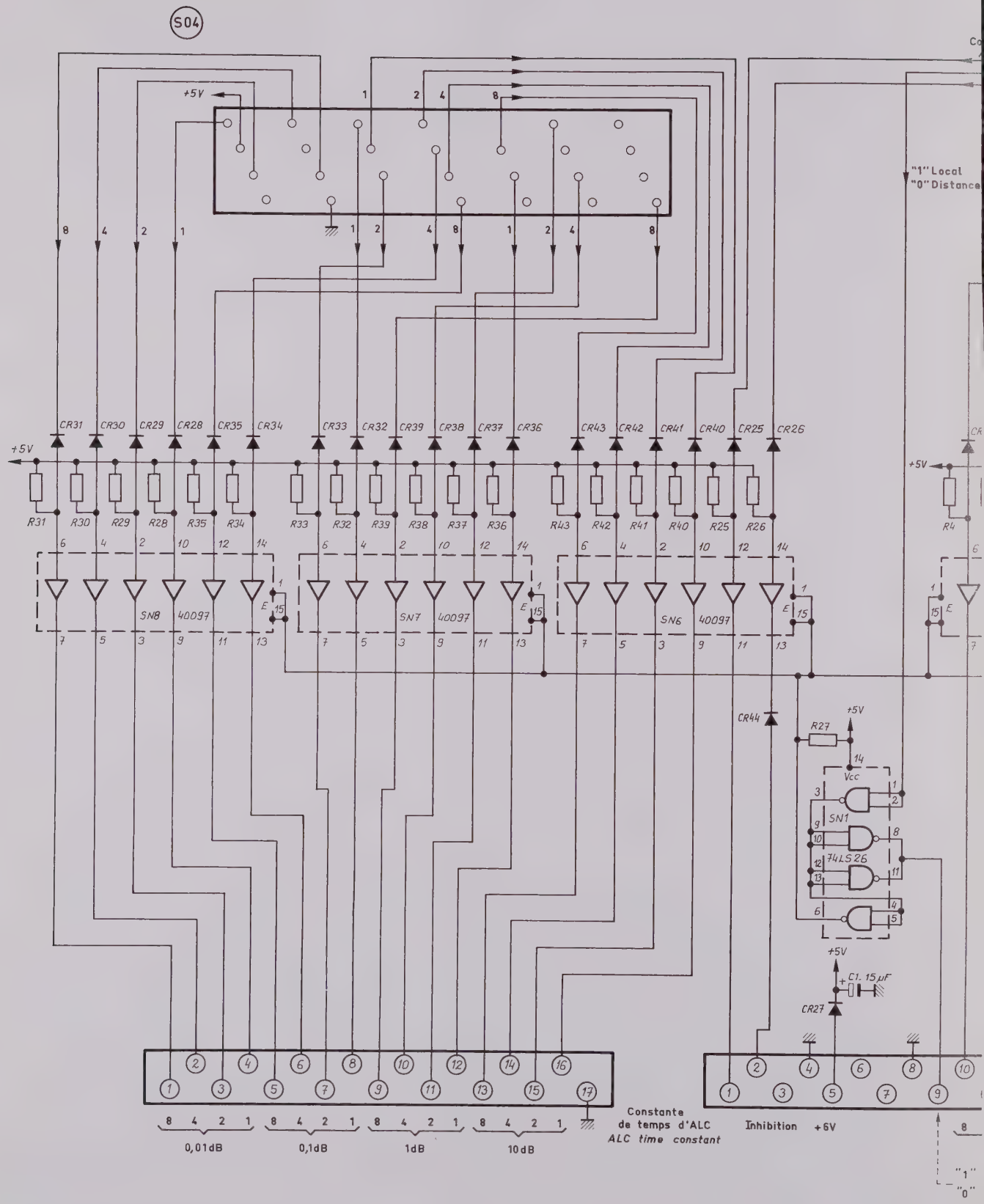
2230 A

REGISTRES BUS IEC

IEEE BUS REGISTERS

PAGE : 1 / 1

9 7 6 9 9 7


S04
+5V
1 2 4 8
"1" Local
"0" Distance
CR31 CR30 CR29 CR28 CR35 CR34 CR33 CR32 CR39 CR38 CR37 CR36 CR43 CR42 CR41 CR40 CR25 CR26
R31 R30 R29 R28 R35 R34 R33 R32 R39 R38 R37 R36 R43 R42 R41 R40 R25 R26
SN8 40097
SN7 40097
SN6 40097
R4
CR44
R27
Vcc
SN1
74LS26
C1. 15µF
CR27
0,01dB
0,1dB
1dB
10dB
Constante
de temps d'ALC
ALC time constant
Inhibition +6V
"1"
"0"

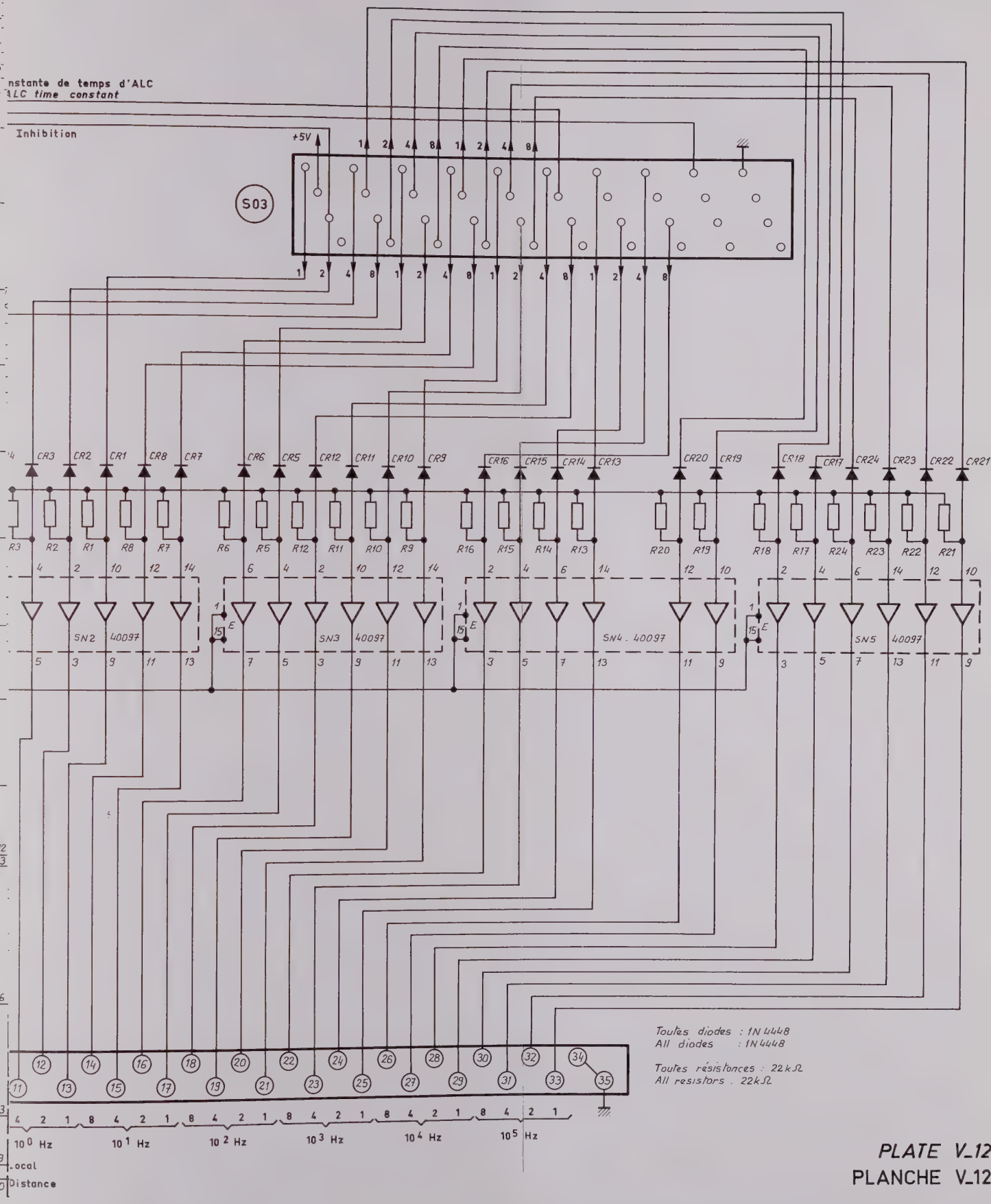

nstante de temps d'ALC
LC time constant
Inhibition
+5V
S03
1 2 4 8 1 2 4 8
CR3 CR2 CR1 CR8 CR7 CR6 CR5 CR12 CR11 CR10 CR9 CR16 CR15 CR14 CR13 CR20 CR19 CR18 CR17 CR24 CR23 CR22 CR21
R3 R2 R1 R8 R7 R6 R5 R12 R11 R10 R9 R16 R15 R14 R13 R20 R19 R18 R17 R24 R23 R22 R21
SN2 40097
SN3 40097
SN4 . 40097
SN5 40097
Toutes diodes : 1N 4448
All diodes : 1N 4448
Toutes résistances : 22 kΩ
All resistors . 22 kΩ
10 0 Hz
10 1 Hz
10 2 Hz
10 3 Hz
10 4 Hz
10 5 Hz
ocal
Distance

PLATE V_12
PLANCHE V_12

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ÉTUDIE	DESSINÉ	VÉRIFIÉ
	ACORT	

2230 A
PROGRAMMATION BCD PARALLELE
PARALLEL BCD PROGRAMMING

DATE : JUILLET 1978

PAGE : 1 / 1

9 7 6 9 1 3

NOMENCLATURES

PARTS LIST

97 6905	GENERATION 10^0 Hz - 10^1 Hz - 10^2 Hz *GENERATION 10^0 Hz – 10^1 Hz – 10^2 Hz*	VII-2
97 6906	GENERATION 10^3 Hz - 10^4 Hz - 10^5 Hz *GENERATION 10^3 Hz – 10^4 Hz – 10^5 Hz*	VII-4
97 6907	DEMODULATEUR - AMPLIFICATEUR *DEMODULATOR – AMPLIFIER*	VII-7
97 6908	CODAGE NIVEAU DE SORTIE *OUTPUT LEVEL CODING*	VII-11
97 6910	MODULE DE SORTIE *OUTPUT MODULE*	VII-13
97 7003	CIRCUITS DE COMMANDE *CONTROL CIRCUITS*	VII-15
97 6915	ALIMENTATION *POWER SUPPLY*	VII-17
97 7094	AMPLIFICATEUR Z < 1 Ω *Z < 1 Ω AMPLIFIER*	VII-18
97 6998	ISOLATEUR BUS IEC *IEEE BUS ISOLATOR*	VII-19
97 6997	REGISTRES BUS IEC *IEEE BUS REGISTERS*	VII-20
97 6913	PROGRAMMATION BCD PARALLELE *PARALLEL BCD PROGRAMMING*	VII-21
	PANNEAU AVANT / PANNEAU ARRIERE *FRONT PANEL / REAR PANEL*	VII-22

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTORS*			
R1	22 100051	51 Ω 5 % 1/4 W	SOVCOR SO7
R2	22 100315	15 kΩ 5 % 1/4 W	SOVCOR SO7
R3	22 100047	47 Ω 5 % 1/4 W	SOVCOR SO7
R4	22 100210	1 kΩ 5 % 1/4 W	SOVCOR SO7
R5	22 100315	15 kΩ 5 % 1/4 W	SOVCOR SO7
R6	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR SO7
R7	22 100122	220 Ω 5 % 1/4 W	SOVCOR SO7
R8	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR SO7
R9	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R10	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR SO7
R11	22 100127	270 Ω 5 % 1/4 W	SOVCOR SO7
R12	22 100115	150 Ω 5 % 1/4 W	SOVCOR SO7
R13	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR SO7
R14	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR SO7
R15	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R16	22 100218	1,8 kΩ 5 % 1/4 W	SOVCOR SO7
R17	22 000310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R18	22 100133	330 Ω 5 % 1/4 W	SOVCOR SO7
R19	22 100112	120 Ω 5 % 1/4 W	SOVCOR SO7
R20	22 100212	1,2 kΩ 5 % 1/4 W	SOVCOR SO7
R21	22 100256	5,6 kΩ 5 % 1/4 W	SOVCOR SO7
R22	22 100410	100 kΩ 5 % 1/4 W	SOVCOR SO7
R23	22 100047	47 Ω 5 % 1/4 W	SOVCOR SO7
R24	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R25	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR SO7
R26	22 100322	22 kΩ 5 % 1/4 W	SOVCOR SO7
R27	22 100210	1 kΩ 5 % 1/4 W	SOVCOR SO7
R28	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R29	22 100315	15 kΩ 5 % 1/4 W	SOVCOR SO7
R30	22 100315	15 kΩ 5 % 1/4 W	SOVCOR SO7
R31	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR SO7
R32	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R33	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R34	22 100056	56 Ω 5 % 1/4 W	SOVCOR SO7
R35	22 100051	51 Ω 5 % 1/4 W	SOVCOR SO7
R36	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R37 à R48 *R37 through R48*	22 100347	47 kΩ 5 % 1/4 W	SOVCOR SO7
CONDENSATEURS *CAPACITORS*			
C1	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C2	31 200110	100 pF 2 % 100 V	COGECO C 632
C3	37 001800	15 µF +50 -10 % 16 V	RTC 122
C4	37 001800	15 µF +50 -10 % 16 V	RTC 122
C5	37 001800	15 µF +50 -10 % 16 V	RTC 122
C6	31 200133	330 pF 2 % 100 V	COGECO C 632
C7	——	Ajusté en fabrication *Factory adjusted*	COGECO C 632
C8	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C9	31 200122	220 pF 2 % 100 V	COGECO C 632
C10	31 200122	220 pF 2 % 100 V	COGECO C 632
C11	31 200210	1 nF 10 % 100 V	COGECO C 630
C12	36 000700	5,5 pF/65 pF	RTC CO 10
C13	36 000300	1,5 pF/6 pF	STETTNER 112 C
C14	37 001800	15 µF +50 -10 % 16 V	RTC 122
C15	37 001800	15 µF +50 -10 % 16 V	RTC 122
C16	32 242202	0,22 µF 10 % 40 V	PRECIS CKM 501
C17	32 324700	4,7 nF 10 % 400 V	COGECO C 280
C18	37 001800	15 µF +50 -10 % 16 V	RTC 122
C19	32 333300	33 nF 10 % 250 V	COGECO C 280
C20	31 200018	18 pF 2 % 100 V	COGECO C 632
C21	——	Ajusté en fabrication *Factory adjusted*	COGECO C 632
C22	31 200210	1 nF 10 % 100 V	COGECO C 630
C23	31 200033	33 pF 2 % 100 V	COGECO C 632

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
C24	31 200210	1 nF 10 % 100 V	COGECO C 630
C25	37 001800	15 µF +50 -10 % 16 V	RTC 122
C26	37 001800	15 µF +50 -10 % 16 V	RTC 122
C27	37 001800	15 µF +50 -10 % 16 V	RTC 122
BOBINAGES *COILS*			
T1	02 182500	Neosid F2	ADRET
T2	02 179900	Neosid F10b	ADRET
QUARTZ *CRYSTAL*	51 003400	5 MHz	QUARTZ ELECTRONIQUE
DIODES *DIODES*			
CR1	45 003100	1 N 4448	SESCOSEM
CR2	46 000500	ZPP 6,2 V	ITT
CR3	45 002600	BB 109	RTC
CR4	45 003100	1 N 4448	SESCOSEM
CR5	45 003100	1 N 4448	SESCOSEM
TRANSISTORS *TRANSISTORS*			
Q1	43 000500	2 N 2369	TEXAS
Q2	43 000500	2 N 2369	TEXAS
Q3	43 001900	BC 184 C	TEXAS
Q4	43 001100	BC 214 C	TEXAS
Q5	43 001900	BC 184 C	TEXAS
Q6	43 000500	2 N 2369	TEXAS
Q7	43 000500	2 N 2369	TEXAS
Q8	44 001000	E 304	SILICONIX
Q9	43 001100	BC 214 C	TEXAS
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1	41 507402	74 LS 02	TEXAS
SN2	41 507490	74 LS 90	TEXAS
SN3	41 604518	4518	RTC
SN4	41 604518	4518	RTC
SN5	41 604027	4027	RTC
SN6	41 604023	4023	RTC
SN7	41 507400	74 LS 00	TEXAS
SN8	41 507490	74 LS 90	TEXAS
SN9	41 604518	4518	RTC
SN10	41 574112	74 LS 112	TEXAS
SN11	41 574112	74 LS 112	TEXAS
SN12	41 574112	74 LS 112	TEXAS
SN13	41 574112	74 LS 112	TEXAS
SN14	41 507420	74 LS 20	TEXAS
SN15	41 507420	74 LS 20	TEXAS
SN16	41 604585	4585	RTC
SN17	41 604585	4585	RTC
SN18	41 604522	4522	RTC
SN19	41 604526	4526	RTC
CONNECTEUR *CONNECTOR*			
	14 270116	TM 27 MCIG	TRELEC

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTORS*			
R1	22 100312	12 kΩ 5 % 1/4 W	SOVCOR S07
R2	22 100210	1 kΩ 5 % 1/4 W	SOVCOR S07
R3	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R4	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R5	22 100210	1 kΩ 5 % 1/4 W	SOVCOR S07
R6	22 100215	1,5 kΩ 5 % 1/4 W	SOVCOR S07
R7	22 100315	15 kΩ 5 % 1/4 W	SOVCOR S07
R8	22 100182	820 Ω 5 % 1/4 W	SOVCOR S07
R9	22 100068	68 Ω 5 % 1/4 W	SOVCOR S07
R10	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R11 à R22 *R11 through R22*	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R23	22 100043	43 Ω 5 % 1/4 W	SOVCOR S07
R24	22 100115	150 Ω 5 % 1/4 W	SOVCOR S07
R25	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R26	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R27	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R28	22 100139	390 Ω 5 % 1/4 W	SOVCOR S07
R29	22 100139	390 Ω 5 % 1/4 W	SOVCOR S07
R30	25 000909	909 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R31	25 000909	909 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R32	22 100236	3,6 kΩ 5 % 1/4 W	SOVCOR S07
R33	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R34	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R35	22 100168	680 Ω 5 % 1/4 W	SOVCOR S07
R36	25 000392	392 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R37	25 000392	392 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R38	22 100210	1 kΩ 5 % 1/4 W	SOVCOR S07
R39	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R40	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R41	22 100333	33 kΩ 5 % 1/4 W	SOVCOR S07
R42	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R43	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R44	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R45	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R46	22 100333	33 kΩ 5 % 1/4 W	SOVCOR S07
R47	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R48	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R49	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R50	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R51	22 100439	390 kΩ 5 % 1/4 W	SOVCOR S07
R52	22 100439	390 kΩ 5 % 1/4 W	SOVCOR S07
R53	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R54	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R55	22 100112	120 Ω 5 % 1/4 W	SOVCOR S07
R56	22 100115	150 Ω 5 % 1/4 W	SOVCOR S07
R57	25 001825	8,25 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R58	25 001825	8,25 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R59	22 100227	2,7 kΩ 5 % 1/4 W	SOVCOR S07
R60	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R61	22 100268	6,8 kΩ 5 % 1/4 W	SOVCOR S07
R62	25 001392	3,92 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R63	25 001392	3,92 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R64	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R65	22 100333	33 kΩ 5 % 1/4 W	SOVCOR S07
R66	22 100210	1 kΩ 5 % 1/4 W	SOVCOR S07
R67	22 100147	470 Ω 5 % 1/4 W	SOVCOR S07
R68	22 100210	1 kΩ 5 % 1/4 W	SOVCOR S07
R69	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R70	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R71	22 100210	1 kΩ 5 % 1/4 W	SOVCOR S07
R72	22 100215	1,5 kΩ 5 % 1/4 W	SOVCOR S07
R73	22 100315	15 kΩ 5 % 1/4 W	SOVCOR S07
R74	22 100182	820 Ω 5 % 1/4 W	SOVCOR S07
R75	22 100068	68 Ω 5 % 1/4 W	SOVCOR S07

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
R76	22 100118	180 Ω 5 % 1/4 W	SOVCOR SO7
R77	22 100118	180 Ω 5 % 1/4 W	SOVCOR SO7
R78	22 100210	1 kΩ 5 % 1/4 W	SOVCOR SO7
R79	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R80	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
CONDENSATEURS *CAPACITORS*			
C1	32 322200	2,2 nF 10 % 400 V	COGECO C 280
C2	32 336800	68 nF 10 % 250 V	COGECO C 280
C3	——	Ajusté en fabrication *Factory adjusted*	COGECO C 632
C4	31 200022	22 pF 2 % 100 V	COGECO C 632
C5	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C6	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C7	31 200210	1 nF 10 % 100 V	COGECO C 630
C8	37 001800	15 µF +50 -10 % 16 V	RTC 122
C9	37 001800	15 µF +50 -10 % 16 V	RTC 122
C10	37 001800	15 µF +50 -10 % 16 V	RTC 122
C11	31 200210	1 nF 10 % 100 V	COGECO C 630
C12	31 200210	1 nF 10 % 100 V	COGECO C 630
C13	32 331000	10 nF 10 % 250 V	COGECO C 280
C14	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C15	37 001800	15 µF +50 -10 % 16 V	RTC 122
C16	37 001800	15 µF +50 -10 % 16 V	RTC 122
C17	31 200082	82 pF 2 % 100 V	COGECO C 632
C18	31 200082	82 pF 2 % 100 V	COGECO C 632
C19	31 200082	82 pF 2 % 100 V	COGECO C 632
C20	31 200082	82 pF 2 % 100 V	COGECO C 632
C21	31 200082	82 pF 2 % 100 V	COGECO C 632
C22	31 200082	82 pF 2 % 100 V	COGECO C 632
C23	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C24	32 332200	22 nF 10 % 250 V	COGECO C 280
C25	37 001800	15 µF +50 -10 % 16 V	RTC 122
C26	31 200210	1 nF 10 % 100 V	COGECO C 630
C27	32 334700	47 nF 10 % 250 V	COGECO C 280
C28	37 000400	1 µF 20 % 35 V	LTT CTS 13
C29	31 200022	22 pF 2 % 100 V	COGECO C 632
C30	——	Ajusté en fabrication *Factory adjusted*	COGECO C 632
C31	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C32	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C33	31 200210	1 nF 10 % 100 V	COGECO C 630
C34	37 001800	15 µF +50 -10 % 16 V	RTC 122
C35	31 200082	82 pF 2 % 100 V	COGECO C 632
C36	31 200210	1 nF 10 % 100 V	COGECO C 630
C37	31 200039	39 pF 2 % 100 V	COGECO C 632
C38	——	Ajusté en fabrication *Factory adjusted*	COGECO C 632
C39	37 001800	15 µF +50 -10 % 16 V	RTC 122
C40	31 200033	33 pF 2 % 100 V	COGECO C 632
BOBINAGES *COILS*			
T1	02 180000	Neosid F10b	ADRET
T2	02 180000	Neosid F10b	ADRET
T3	02 182400	Neosid F10b	ADRET
T4	02 180200	Neosid F10b	ADRET
DIODES *DIODES*			
CR1 à CR4 *CR1 through CR4*	02 065200	*Selected* BB 109 triée	ADRET
CR5	46 000300	ZPD 5,1 V	ITT
CR6	45 000200	1 N 4151	SESCOSEM
CR7	45 000200	1 N 4151	SESCOSEM
CR8	45 003100	1 N 4448	SESCOSEM

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
CR9	45 003100	1 N 4448	SESCOSEM
CR10	45 003100	1 N 4448	SESCOSEM
CR11 à CR14 *CR11 through CR14*	02 065200	*Selected* BB 109 triée	ADRET
CR15	46 000300	ZPD 5,1 V	ITT
CR16	45 003100	1 N 4448	SESCOSEM
CR17	45 003100	1 N 4448	SESCOSEM
TRANSISTORS *TRANSISTORS*			
Q1	43 000400	2 N 918	SGS
Q2	43 003200	2 N 2894 A	MOTOROLA
Q3	43 000500	2 N 2369	TEXAS
Q4	43 000400	2 N 918	SGS
Q5	43 002200	BF 272	SGS
Q6	43 000400	2 N 918	SGS
Q7	43 001100	BC 214 C	TEXAS
Q8	43 001100	BC 214 C	TEXAS
Q9	43 000400	2 N 918	SGS
Q10	43 000400	2 N 918	SGS
Q11	43 002200	BF 272	SGS
Q12	43 001900	BC 184 C	TEXAS
Q13	43 001100	BC 214 C	TEXAS
Q14	43 000400	2 N 918	SGS
Q15	43 003200	2 N 2894 A	MOTOROLA
Q16	43 000500	2 N 2369	TEXAS
Q17	43 001900	BC 184 C	TEXAS
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1	41 574112	74 LS 112	TEXAS
SN2	41 574112	74 LS 112	TEXAS
SN3	41 574112	74 LS 112	TEXAS
SN4	41 574112	74 LS 112	TEXAS
SN5	41 507420	74 LS 20	TEXAS
SN6	41 507420	74 LS 20	TEXAS
SN7	41 604585	4585	RTC
SN8	41 604585	4585	RTC
SN9	41 604522	4522	RTC
SN10	41 604526	4526	RTC
SN11	41 604560	4560	MOTOROLA
SN12	41 604560	4560	MOTOROLA
SN13	41 507420	74 LS 20	TEXAS
SN14	41 574112	72 LS 112	TEXAS
SN15	41 604027	4027	RTC
SN16	41 507486	74 LS 86	TEXAS
SN17	41 604081	4081	RTC
SN18	41 604027	4027	RTC
SN19	41 574112	74 LS 112	TEXAS
SN20	41 107400	7400	TEXAS
CONNECTEUR *CONNECTOR*			
	14 270116	TM 27 MCIG	TRELEC

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTANCES*			
R1	22 100210	1 kΩ 5 % 1/4 W	SOVCOR S07
R2	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R3	22 100227	2,7 kΩ 5 % 1/4 W	SOVCOR S07
R4	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R5	25 002100	10 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R6	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R7	22 100312	12 kΩ 5 % 1/4 W	SOVCOR S07
R8	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR S07
R9	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R10	22 100410	100 kΩ 5 % 1/4 W	SOVCOR S07
R11	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR S07
R12	22 100227	2,7 kΩ 5 % 1/4 W	SOVCOR S07
R13	22 100239	3,9 kΩ 5 % 1/4 W	SOVCOR S07
R14	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R15	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R16	22 100147	470 Ω 5 % 1/4 W	SOVCOR S07
R17	22 100227	2,7 kΩ 5 % 1/4 W	SOVCOR S07
R18	22 100227	2,7 kΩ 5 % 1/4 W	SOVCOR S07
R19	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR S07
R20	22 100312	12 kΩ 5 % 1/4 W	SOVCOR S07
R21	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R22	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R23	25 000464	464 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R24	25 000464	464 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R25	22 100191	910 Ω 5 % 1/4 W	SOVCOR S07
R26	22 100122	220 Ω 5 % 1/4 W	SOVCOR S07
R27	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R28	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR S07
R29	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R30	22 100215	1,5 kΩ 5 % 1/4 W	SOVCOR S07
R31	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R32	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R33	25 000249	249 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R34	25 000249	249 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R35	22 100268	6,8 kΩ 5 % 1/4 W	SOVCOR S07
R36	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR S07
R37	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R38	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R39	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R40	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R41	25 001100	1 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R42	25 001100	1 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R43	25 001681	6,81 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R44	25 001681	6,81 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R45	25 001562	5,62 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R46	25 001562	5,62 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R47	22 100012	12 Ω 5 % 1/4 W	SOVCOR S07
R48	22 100012	12 Ω 5 % 1/4 W	SOVCOR S07
R49	25 000221	221 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R50	25 000221	221 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R51	25 009249	24,9 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R52	25 009249	24,9 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R53	23 000947	4,7 Ω 5 % 1/4 W	BEYSCHLAG B3
R54	23 000956	5,6 Ω 5 % 1/4 W	BEYSCHLAG B3
R55	23 000956	5,6 Ω 5 % 1/4 W	BEYSCHLAG B3
R56	25 001100	1 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R57	25 000100	100 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R58	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R59	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R60	25 001301	3,01 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R61	25 001301	3,01 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R62	25 001499	4,99 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R63	25 001499	4,99 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R64	22 100322	22 kΩ 5 % 1/4 W	SOVCOR S07
R65	22 100322	22 kΩ 5 % 1/4 W	SOVCOR S07
R66	25 009487	48,7 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R67	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR S07

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
R68	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R69	22 100115	150 Ω 5 % 1/4 W	SOVCOR S07
R70	22 100222	2,2 kΩ Ω 5 % 1/4 W	SOVCOR S07
R71	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R72	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR S07
R73	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR S07
R74	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R75	25 001100	1 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R76	22 100133	330 Ω 5 % 1/4 W	SOVCOR S07
R77	25 001150	1,5 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R78	29 000110	100 Ω 5 % 1/8 W	SOVCOR C3
R79	25 001243	2,43 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R80	22 100056	56 Ω 5 % 1/4 W	SOVCOR S07
R81	25 000226	226 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R82	25 000226	226 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R83	25 001243	2,43 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R84	25 001576	5,76 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R85	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R86	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R87	22 100047	47 Ω 5 % 1/4 W	SOVCOR S07
R88	22 100047	47 Ω 5 % 1/4 W	SOVCOR S07
R89	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R90	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R91	22 100322	22 kΩ 5 % 1/4 W	SOVCOR S07
R92	25 002100	10 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R93	25 002100	10 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R94	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R95	22 100310	10 Ω 5 % 1/4 W	SOVCOR S07
R96	25 002100	10 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R97	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR S07
R98	25 002150	15 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R99	22 100412	120 kΩ 5 % 1/4 W	SOVCOR S07
R100	22 100522	2,2 MΩ 5 % 1/4 W	ROSENTHAL LCA 309
R101	25 001681	6,81 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R102	23 000947	4,7 Ω 5 % 1/4 W	BEYSCHLAG B3
R103	23 000947	4,7 Ω 5 % 1/4 W	BEYSCHLAG B3
R104	22 100051	51 Ω 5 % 1/4 W	SOVCOR S07
POTENTIOMETRES *POTENTIOMETERS*			
P1	21 332200	22 kΩ 20 % 3/4 W	BECKMANN 89 P
P2	21 332200	22 kΩ 20 % 3/4 W	BECKMANN 89 P
CONDENSATEURS *CAPACITORS*			
C1	37 001400	10 µF 20 % 25 V	LTT CTS 13
C2	32 341000	0,1 µF 10 % 250 V	COGECO C 280
C3	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C4	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C5	31 200210	1 nF 10 % 100 V	COGECO C 630
C6	31 200133	330 pF 2 % 100 V	COGECO C 632
C7	31 200133	330 pF 2 % 100 V	COGECO C 632
C8	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C9	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C10	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C11	37 001800	15 µF +50 -10 % 16 V	RTC 122
C12	33 002490	249 pF 2 % 250 V	LAFAB TVE 15
C13	31 200015	15 pF 2 % 100 V	COGECO C 632
C14	33 012001	2 nF 5 % 250 V	LAFAB TVE 15
C15	33 012001	2 nF 5 % 250 V	LAFAB TVE 15
C16	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C17	31 200210	1 nF 10 % 100 V	COGECO C 630
C18	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C19	37 001800	15 µF +50 -10 % 16 V	RTC 122
C20	31 200133	330 pF 2 % 100 V	COGECO C 632
C21	31 200133	330 pF 2 % 100 V	COGECO C 632
C22	31 200115	150 pF 2 % 100 V	COGECO C 632
C23	31 200115	150 pF 2 % 100 V	COGECO C 632

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
C24	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C25	37 001800	15 µF +50 -10 % 16 V	RTC 122
C26	37 001800	15 µF +50 -10 % 16 V	RTC 122
C27	31 200010	10 pF 2 % 100 V	COGECO C 632
C28	31 200082	82 pF 2 % 100 V	COGECO C 632
C29	31 200112	120 pF 2 % 100 V	COGECO C 632
C30	31 200115	150 pF 2 % 100 V	COGECO C 632
C31	31 200110	10 pF 2 % 100 V	COGECO C 632
C32	31 200082	82 pF 2 % 100 V	COGECO C 632
C33	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C34	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C35	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
C36	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
C37	———	Ajusté en fabrication *Factory adjusted*	COGECO C 632
C38	37 001800	15 µF +50 -10 % 16 V	RTC 122
C39	37 001800	15 µF +50 -10 % 16 V	RTC 122
C40	37 001800	15 µF +50 -10 % 16 V	RTC 122
C41	37 001800	15 µF +50 -10 % 16 V	RTC 122
C42	32 242202	0,22µF 10 % 40 V	PRECIS CKM 501
C43	32 242202	0,22µF 10 % 40 V	PRECIS CKM 501
C44	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C45	37 001800	15 µF +50 -10 % 16 V	RTC 122
C46	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C47	37 001800	15 µF +50 -10 % 16 V	RTC 122
C48	37 001800	15 µF +50 -10 % 16 V	RTC 122
C49	31 200082	82 pF 2 % 100 V	COGECO C 632
C50	37 001000	4,7µF +50 -10 % 25 V	RTC 122
C51	32 341000	0,1 µF 10 % 250 V	COGECO C 280
C52	32 341000	0,1 µF 10 % 250 V	COGECO C 280
C53	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C54	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
BOBINAGES *COILS*			
T1	02 180300	Neosid F2	ADRET
T2	02 180400	Neosid F2	ADRET
T3	02 162800	Neosid F2	ADRET
T4	02 180500	Neosid F2	ADRET
T5	02 180600	Neosid F2	ADRET
T6	02 171700	Neosid F2	ADRET
T7	02 171700	Neosid F2	ADRET
T8	02 172800	Cofelec FT5-T6	ADRET
DIODES *DIODES*			
CR1 à CR14 *CR1 through CR14*	45 000200	1 N 4151	SESCOSEM
CR15	45 004000	ESM 246	SESCOSEM
CR16	45 004000	ESM 246	SESCOSEM
TRANSISTORS *TRANSISTORS*			
Q1	43 001900	BC 184 C	TEXAS
Q2	43 001100	BC 214 C	TEXAS
Q3	43 001900	BC 184 C	TEXAS
Q4	43 001900	BC 184 C	TEXAS
Q5	43 000500	2 N 2369	TEXAS
Q6	43 000500	2 N 2369	TEXAS
Q7	43 001900	BC 184 C	TEXAS
Q8	43 001100	BC 214 C	TEXAS
Q9	43 001100	BC 214 C	TEXAS
Q10	43 001900	BC 184 C	TEXAS
Q11	43 001900	BC 184 C	TEXAS
Q12	43 001100	BC 214 C	TEXAS
Q13	43 001900	BC 184 C	TEXAS
Q14	48 000800	2 N 2905	TEXAS

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
Q15	48 000600	2 N 2219	TEXAS
Q16	48 000600	2 N 2219	TEXAS
Q17	48 000800	2 N 2905	TEXAS
Q18	43 000100	2 N 2222	TEXAS
Q19	43 001000	2 N 2907	TEXAS
Q20	43 001100	BC 214 C	TEXAS
Q21	43 000500	2 N 2369	TEXAS
Q22	43 000500	2 N 2369	TEXAS
Q23	43 000400	2 N 918	SGS
Q24	43 000400	2 N 918	SGS
Q25	43 001300	BFR 99	SGS
Q26	43 001400	2 N 5179	RCA
CIRCUITS INTEGRES *INTEGRATED CITCUITS*			
SN1	42 000900	741	MOTOROLA
SN2	42 001100	TBA 673	RTC
SN3	42 000900	741	MOTOROLA
SN4	42 000900	741	MOTOROLA
SN5	42 001800	1458	MOTOROLA
CONNECTEUR *CONNECTOR*			
	14 230004	TM 23 MCIG	TRELEC

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTORS*			
R1	22 100068	68 Ω 5 % 1/4 W	SOVCOR SO7
R2	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R3	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R4	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R5	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R6	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R7	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R8	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R9	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R10	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R11	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR SO7
R12	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR SO7
R13	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR SO7
R14	22 100018	18 Ω 5 % 1/4 W	SOVCOR SO7
R15	22 100110	100 Ω 5 % 1/4 W	SOVCOR SO7
R16	22 100110	100 Ω 5 % 1/4 W	SOVCOR SO7
R17	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R18	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R19	22 100327	27 kΩ 5 % 1/4 W	SOVCOR SO7
R20	25 001196	1,96 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R21	25 001422	4,22 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R22	25 002187	18,7 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R23	22 100182	820 Ω 5 % 1/4 W	SOVCOR SO7
R24	22 100212	1,2 kΩ 5 % 1/4 W	SOVCOR SO7
R25	22 100510	1 MΩ 5 % 1/4 W	SOVCOR SO7
R26	25 003499	499 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R27	25 003249	249 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R28	25 003124	124 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R29	25 003100	100 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R30	25 002499	49,9 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R31	25 002909	90,9 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R32	25 002442	44,2 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R33	25 002866	86,6 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R34	25 002210	21 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R35	26 011043	10,43 kΩ 0,25 % 1/10 W	HOLCO H10
R36	26 005000	5 kΩ 0,25 % 1/10 W	HOLCO H10
R37	26 005000	5 kΩ 0,25 % 1/10 W	HOLCO H10
R38	26 005000	5 kΩ 0,25 % 1/10 W	HOLCO H10
R39	26 011000	10 kΩ 0,25 % 1/10 W	HOLCO H10
R40	26 013010	30,1 kΩ 0,25 % 1/10 W	HOLCO H10
R41	26 011090	10,9 kΩ 0,25 % 1/10 W	HOLCO H10
R42	25 002787	78,7 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R43	25 002806	80,6 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R44	25 002316	31,6 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R45	25 003110	110 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R46 à R61 *R46 through R61*	22 100347	47 kΩ 5 % 1/4 W	SOVCOR SO7
R62	26 001180	1,18 kΩ 0,25 % 1/10 W	HOLCO H10
POTENTIOMETRES *POTENTIOMETERS*			
P1	21 531000	10 kΩ 20 % 3/4 W	SFERNICE T7YA
P2	21 531000	10 kΩ 20 % 3/4 W	SFERNICE T7YA
P3	21 524700	4,7 kΩ 20 % 3/4 W	SFERNICE T7YA
P4	21 521000	1 kΩ 20 % 3/4 W	SFERNICE T7YA
P5	21 532200	22 kΩ 20 % 3/4 W	SFERNICE T7YA
CONDENSATEURS *CAPACITORS*			
C1	37 001800	15 µF +50 -10 % 16 V	RTC 122
C2	37 001800	15 µF +50 -10 % 16 V	RTC 122
C3	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
C4	37 001800	15 µF +50 -10 % 16 V	RTC 122
C5	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C6	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
DIODES *DIODES*			
CR1	45 000200	1 N 4151	SESCOSEM
CR2	45 000200	1 N 4151	SESCOSEM
CR3	45 000200	1 N 4151	SESCOSEM
CR4	45 000200	1 N 4151	SESCOSEM
CR5	46 000300	ZPD 5,1 V	ITT
CR6	46 000800	ZPD 6,8 V	ITT
TRANSISTORS *TRANSISTORS*			
Q1	48 000600	2 N 2219	TEXAS
Q2	48 000600	2 N 2219	TEXAS
Q3	48 000600	2 N 2219	TEXAS
Q4	43 001100	BC 214 C	TEXAS
Q5	43 001100	BC 214 C	TEXAS
Q6	43 001100	BC 214 C	TEXAS
Q7	43 001900	BC 184 C	TEXAS
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1	41 604028	4028	RTC
SN2	41 604072	4072	RTC
SN3	41 604072	4072	RTC
SN4	42 003200	LF 356	NS
SN5	42 003200	LF 356	NS
SN6	41 604561	4561	MOTOROLA
SN7	41 604561	4561	MOTOROLA
SN8	41 604561	4561	MOTOROLA
SN9	41 604053	4053	RTC
SN10	41 604053	4053	RTC
SN11	41 604053	4053	RTC
SN12	41 604053	4053	RTC
SN13	41 604053	4053	RTC
CONNECTEUR *CONNECTOR*			
	14 270116	TM 27 MCIG	TRELEC

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
		02 6911	
RESISTANCES *RESISTORS*			
R1	26 091444	144,4 Ω 0,25 % 1/8 W	GEKA AVM
R2	26 091066	106,6 Ω 0,25 % 1/8 W	GEKA AVM
R3	26 091444	144,4 Ω 0,25 % 1/8 W	GEKA AVM
R4	26 089160	91,6 Ω 0,25 % 1/8 W	GEKA AVM
R5	26 837125	371,25 Ω 0,1 % 1/8 W	GEKA AVL
R6	26 089160	91,6 Ω 0,25 % 1/8 W	GEKA AVM
R7	26 087650	76,5 Ω 0,25 % 1/8 W	GEKA AVM
R8	26 937500	3,75 kΩ 0,1 % 1/8 W	GEKA AVL
R9	26 087650	76,5 Ω 0,25 % 1/8 W	GEKA AVM
R10	25 009249	24,9 Ω 1 % 1/5 W	ROSENTHAL SMA 207
CONDENSATEURS *CAPACITORS*			
C1	31 200210	1 nF 10 % 100 V	COGECO C 630
C2	31 200210	1 nF 10 % 100 V	COGECO C 630
C3	31 200210	1 nF 10 % 100 V	COGECO C 630
—	31 004300	1 nF by-pass	STETTNER BDBQ5
DIODES *DIODES*			
CR1	45 003100	1 N 4448	SESCOSEM
CR2	45 003100	1 N 4448	SESCOSEM
CR3	45 003100	1 N 4448	SESCOSEM
RELAIS *RELAY*	16 000900	RZ 12 V	ITT
CONNECTEUR *CONNECTOR*	14 100076	TB 10 M	TRELEC
		02 6912	
RESISTANCES *RESISTORS*			
R1	25 009750	75 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R2	22 100133	330 Ω 5 % 1/4 W	SOVCOR S07
R3	25 000523	523 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R4	25 001100	1 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R5	22 100315	15 kΩ 5 % 1/4 W	SOVCOR S07
R6	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R7	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R8	22 100047	47 Ω 5 % 1/4 W	SOVCOR S07
R9	22 100156	560 Ω 5 % 1/4 W	SOVCOR S07
R10	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR S07
R11	22 100339	39 kΩ 5 % 1/4 W	SOVCOR S07
R12	22 100322	22 kΩ 5 % 1/4 W	SOVCOR S07
R13	22 100322	22 kΩ 5 % 1/4 W	SOVCOR S07
R14	22 100322	22 kΩ 5 % 1/4 W	SOVCOR S07
R15	23 000922	2,2 Ω 5 % 1/4 W	BEYSCHLAG B3
R16	23 000922	2,2 Ω 5 % 1/4 W	BEYSCHLAG B3
R17	25 001464	4,64 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R18	25 001464	4,64 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R19	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R20	25 009249	24,9 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R21	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R22	22 100382	82 kΩ 5 % 1/4 W	SOVCOR S07
R23	25 009732	73,2 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R24	25 009732	73,2 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R25	25 000294	294 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R26	25 000294	294 Ω 1 % 1/5 W	ROSENTHAL SMA 207

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
POTENTIOMETRE *POTENTIOMETER*			
P1	21 524700	4,7 kΩ 20 % 3/4 W	SFERNICE T7YA
CONDENSATEURS *CAPACITORS*			
C1	37 001800	15 µF +50 -10 % 16 V	RTC 122
C2	37 001800	15 µF +50 -10 % 16 V	RTC 122
C3	37 000200	1 µF +50 -10 % 25 V	RTC 122
C4	37 000200	1 µF +50 -10 % 25 V	RTC 122
C5	31 200015	15 pF 2 % 100 V	COGECO C 632
C6	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C7	37 001800	15 µF +50 -10 % 16 V	RTC 122
C8	32 341000	0,1 µF 10 % 250 V	COGECO C 280
C9	32 341000	0,1 µF 10 % 250 V	COGECO C 280
C10	32 323300	3,3 nF 10 % 400 V	COGECO C 280
C11	31 200047	47 pF 2 % 100 V	COGECO C 632
DIODES *DIODES*			
CR1	45 003100	1 N 4448	SESCOSEM
CR2	45 003100	1 N 4448	SESCOSEM
TRANSISTORS *TRANSISTORS*			
Q1	43 001900	BC 184 C	TEXAS
Q2	48 000600	2 N 2219	TEXAS
Q3	48 000800	2 N 2905	TEXAS
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1	42 003300	LM 318	NS
SN2	42 000900	LM 741	NS
TRANSFORMATEUR *TRANSFORMER*	02 700900	92 0936	ADRET
CLAVIER *KEYBOARD*	15 204123	4 touches *4 keys*	OREOR
CONNECTEURS *CONNECTORS*			
J1	14 002158	BNC R 141-559	RADIALL
J2	14 002172	C 42334A - 176A	SIEMENS

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
		02 6909	
RESISTANCES *RESISTORS*			
R1	22 100122	220 Ω 5 % 1/4 W	SOVCOR S07
R2	22 100212	1,2 kΩ 5 % 1/4 W	SOVCOR S07
R3	22 100168	680 Ω 5 % 1/4 W	SOVCOR S07
R4	22 100233	3,3 kΩ 5 % 1/4 W	SOVCOR S07
R5	22 100051	51 Ω 5 % 1/4 W	SOVCOR S07
R6	22 100022	22 Ω 5 % 1/4 W	SOVCOR S07
R7	22 100022	22 Ω 5 % 1/4 W	SOVCOR S07
CONDENSATEURS *CAPACITORS*			
C1	37 001800	15 µF +50 -10 % 16 V	RTC 122
C2	37 001800	15 µF +50 -10 % 16 V	RTC 122
DIODE *DIODE*			
CR1	45 003100	1 N 4448	SESCOSEM
CLAVIER *KEYBOARD*	15 205124	5 touches *5 keys*	OREOR
		02 7003	
RESISTANCES *RESISTORS*			
R1	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R2	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R3	22 100212	1,2 kΩ 5 % 1/4 W	SOVCOR S07
R4	22 100139	390 Ω 5 % 1/4 W	SOVCOR S07
R5	22 100322	22 kΩ 5 % 1/4 W	SOVCOR S07
R6	22 100033	33 Ω 5 % 1/4 W	SOVCOR S07
R7	25 002100	10 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R8	25 001332	3,32 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R9	25 001787	7,87 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R10	25 002698	69,8 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R11	25 002113	11,3 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R12	22 100182	820 Ω 5 % 1/4 W	SOVCOR S07
R13	25 002402	40,2 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R14	25 002249	24,9 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R15	25 003200	200 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R16	22 100522	2,2 MΩ 5 % 1/4 W	ROSENTHAL LCA 309
R17	25 003100	100 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R18	22 100322	22 kΩ 5 % 1/4 W	SOVCOR S07
R19	22 100210	1 kΩ 5 % 1/4 W	SOVCOR S07
R20	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR S07
R21	22 100133	330 Ω 5 % 1/4 W	SOVCOR S07
R22	22 100133	330 Ω 5 % 1/4 W	SOVCOR S07
R23	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R24	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R25	22 100347	47 kΩ 5 % 1/4 W	SOVCOR S07
R26	22 100310	10 kΩ 5 % 1/4 W	SOVCOR S07
R27	22 100127	270 Ω 5 % 1/4 W	SOVCOR S07
POTENTIOMETRES *POTENTIOMETERS*			
P1	21 331000	10 kΩ 20 % 3/4 W	BECKMANN 89 P
P2	21 324700	4,7 kΩ 20 % 3/4 W	BECKMANN 89 P
CONDENSATEURS *CAPACITORS*			
C1	37 001800	15 µF +50 -10 % 16 V	RTC 122
C2	37 001800	15 µF +50 -10 % 16 V	RTC 122
C3	37 001800	15 µF +50 -10 % 16 V	RTC 122

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
DIODES *DIODES*			
CR1	45 003100	1 N 4448	SESCOSEM
CR2	45 003100	1 N 4448	SESCOSEM
CR3	45 003100	1 N 4448	SESCOSEM
CR4	46 000800	ZPD 6,8 V	ITT
CR5	45 003100	1 N 4448	SESCOSEM
CR6	45 003100	1 N 4448	SESCOSEM
TRANSISTORS *TRANSISTORS*			
Q1	43 000100	2 N 2222	TEXAS
Q2	43 001900	BC 184 C	TEXAS
Q3	43 001900	BC 184 C	TEXAS
Q4	43 001900	BC 184 C	TEXAS
Q5	43 001900	BC 184 C	TEXAS
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1	41 604053	4053	RTC
SN2	42 001800	LM 1458	NS
CLAVIER *KEYBOARD*	15 203122	3 touches *3 keys* 02 7010	OREOR
DIODE *DIODE*	45 003100	1 N 4448	SESCOSEM
COMMUTATEUR *SWITCH*	02 700100	Techno-Profil L2052M	ADRET
NATTES *BRAIDS*			
	02 065000	16 broches *16 pins*	ADRET
	02 701300	26 broches *26 pins*	ADRET
	02 710500	26 broches *26 pins*	ADRET

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTORS*			
R1	22 100256	5,6 kΩ 5 % 1/4 W	SOVCOR SO7
R2	22 100256	5,6 kΩ 5 % 1/4 W	SOVCOR SO7
CONDENSATEURS *CAPACITORS*			
C1	37 001800	15 µF +50 -10 % 16 V	RTC 122
C2	37 001800	15 µF +50 -10 % 16 V	RTC 122
C3	37 001800	15 µF +50 -10 % 16 V	RTC 122
C4	35 004300	6800 µF +50 -10 % 16 V	SIC SAFCO CO 33
C5	35 004400	3300 µF +50 -10 % 40 V	SIC SAFCO CO 33
C6	35 004400	3300 µF +50 -10 % 40 V	SIC SAFCO CO 33
DIODES *DIODES*			
CR1 à CR8 *CR1 through CR8*	45 000400	1 N 4004	ITT
TRANSFORMATEUR *TRANSFORMER*	10 002700	93 2214 A	ADRET
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1	42 002900	7912	RTC
SN2	42 002800	7812	RTC
SN3	42 002200	7806	RTC
CONNECTEURS *CONNECTORS*			
	14 170162	TM 17 FCIDG	TRELEC
	14 230006	TM 23 FCIDG	TRELEC
	14 270117	TM 27 FCIDG	TRELEC
	14 350047	TM 35 FCIDG	TRELEC

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTORS*			
R1	23 000968	6,8 Ω 5 % 1/4 W	BEYSCHLAG B3
R2	23 000968	6,8 Ω 5 % 1/4 W	BEYSCHLAG B3
R3	22 100018	18 Ω 5 % 1/4 W	SOVCOR S07
R4	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R5	25 000499	499 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R6	29 000010	10 Ω 5 % 1/8 W	SOVCOR C3
R7	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R8	25 000137	137 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R9	25 001301	3,01 kΩ 1 % 1/5 W	ROSENTHAL SMA 207
R10	25 000750	750 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R11	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R12	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R13	22 100182	820 Ω 5 % 1/4 W	SOVCOR S07
R14	29 000010	10 Ω 5 % 1/8 W	SOVCOR C3
R15	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R16	25 000137	137 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R17	25 000750	750 Ω 1 % 1/5 W	ROSENTHAL SMA 207
R18	22 100110	100 Ω 5 % 1/4 W	SOVCOR S07
R19	22 100227	2,7 kΩ 5 % 1/4 W	SOVCOR S07
POTENTIOMETRES *POTENTIOMETERS*			
P1	21 314700	470 Ω 20 % 3/4 W	BECKMANN 89 P
P2	21 304700	47 Ω 20 % 3/4 W	BECKMANN 89 P
CONDENSATEURS *CAPACITORS*			
C1	31 200027	27 pF 2 % 100 V	COGECO C 632
C2	31 200027	27 pF 2 % 100 V	COGECO C 632
C3	31 200133	330 pF 2 % 100 V	COGECO C 632
C4	31 200133	330 pF 2 % 100 V	COGECO C 632
C5	37 001800	15 µF +50 -10 % 16 V	RTC 122
C6	37 001800	15 µF +50 -10 % 16 V	RTC 122
C7	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
C8	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
C9	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
C10	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
DIODES *DIODES*			
CR1	45 003100	1 N 4448	SESCOSEM
CR2	45 003100	1 N 4448	SESCOSEM
CR3	45 003100	1 N 4448	SESCOSEM
CR4	45 003100	1 N 4448	SESCOSEM
TRANSISTORS *TRANSISTORS*			
Q1	43 001900	BC 184 C	TEXAS
Q2	43 001100	BC 214 C	TEXAS
Q3	43 001000	2 N 2907	TEXAS
Q4	43 000100	2 N 2222	TEXAS
Q5	48 000600	2 N 2219	TEXAS
Q6	48 000800	2 N 2905	TEXAS

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTORS*			
R1 à R13 *R1 through R13*	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR SO7
R14	22 100322	22 kΩ 5 % 1/4 W	SOVCOR SO7
R15	22 100322	22 kΩ 5 % 1/4 W	SOVCOR SO7
R16	22 100133	330 Ω 5 % 1/4 W	SOVCOR SO7
R17 à R32 *R17 through R32*	22 100322	22 kΩ 5 % 1/4 W	SOVCOR SO7
R33	22 100222	2,2 kΩ 5 % 1/4 W	SOVCOR SO7
CONDENSATEURS *CAPACITORS*			
C1 à C12 *C1 through C12*	31 200133	330 pF 2 % 100 V	COGECO C 632
C13	31 500310	10 nF +50 -20 % 63 V	LCC GOX 767
C14	31 200210	1 nF 10 % 100 V	COGECO C 630
C15	37 002500	68 µF +50 -20 % 6,3 V	RTC 122
C16	37 002500	68 µF +50 -20 % 6,3 V	RTC 122
BOBINAGES *COILS*			
T1	02 181200	Cofelec FT5-T6	ADRET
T2	02 181200	Cofelec FT5-T6	ADRET
T3	02 181200	Cofelec FT5-T6	ADRET
DIODES *DIODES*			
CR1 à CR5 *CR1 through CR5*	45 003100	1 N 4448	SESCOSEM
TRANSISTORS *TRANSISTORS*			
Q1	43 001900	BC 184 C	TEXAS
Q2	43 001900	BC 184 C	TEXAS
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1	41 107414	7414	TEXAS
SN2	41 107414	7414	TEXAS
SN3	41 107438	7438	TEXAS
SN4	40 001100	TIL 113	TEXAS
SN5	41 604050	4050	RTC
SN6	41 604050	4050	RTC
SN7	41 604050	4050	RTC
SN8	41 604050	4050	RTC
NATTES *BRAIDS*			
	02 067000	26 broches *26 pins*	ADRET
	02 067100	26 broches *26 pins*	ADRET
CONNECTEUR *CONNECTOR*			
SO5	14 240184	57 - 2024	AMPHENOL
COMMUTATEURS *SWITCHES*			
K10	15 302145	TS2	JEANRENAUD
K11	15 302145	TS2	JEANRENAUD

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTORS*			
R1	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R5	22 100310	10 kΩ 5 % 1/4 W	SOVCOR SO7
R6	22 100410	100 kΩ 5 % 1/4 W	SOVCOR SO7
R7	22 100247	4,7 kΩ 5 % 1/4 W	SOVCOR SO7
R8 à R14 *R8 through R14*	22 100347	47 kΩ 5 % 1/4 W	SOVCOR SO7
CONDENSATEURS *CAPACITORS*			
C1	37 000200	1 µF +50 -10 % 25 V	RTC 122
C2	36 001200	2 pF/18 pF	RTC CO 10
C3	31 200110	100 pF 2 % 100 V	COGECO C 632
C4	37 001000	4,7 µF +50 -10 % 25 V	RTC 122
C5	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
C6	37 002500	68 µF +50 -10 % 6,3 V	RTC 122
C7	35 002800	470 µF +50 -10 % 16 V	SIC SAFCO CO 33
C8	31 200047	47 pF 2 % 100 V	COGECO C 632
INDUCTANCE *INDUCTOR*			
L1	53 004600	100 µH 10 % 130 mA	OREGA 53800
DIODES *DIODES*			
CR1 à CR5 *CR1 through CR5*	45 000400	1 N 4004	ITT
CR6	45 003100	1 N 4448	SESCOSEM
CR7	45 003100	1 N 4448	SESCOSEM
CR8	45 003100	1 N 4448	SESCOSEM
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1	41 604738	HEF 4738	RTC
SN2	41 604014	4014	RTC
SN3	41 604039	4049	RTC
SN4	41 604556	4556	RTC
SN5	41 604556	4556	RTC
SN6	41 604085	4085	RTC
SN7	41 604002	4002	RTC
SN8	41 604002	4002	RTC
SN9	41 604002	4002	RTC
SN10	41 604027	4027	RTC
SN11	41 604027	4027	RTC
SN12	41 604027	4027	RTC
SN13	41 604082	4082	RTC
SN14 à SN19 *SN14 through SN19*	41 604015	4015	RTC
SN20 à SN29 *SN20 through SN29*	41 604076	4076	RTC
SN30	41 604030	4030	RTC
SN31	41 604027	4027	RTC
SN32	41 507426	74 LS 26	TEXAS
SN33	42 002600	7085	RTC
CONNECTEURS *CONNECTORS*			
	14 170163	TM 17 MCIG	TRELEC
	14 350046	TM 35 MCIG	TRELEC

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
RESISTANCES *RESISTORS*			
R1 à R43 *R1 through R43*	22 100322	22 kΩ 5 % 1/4 W	SOVCOR SO7
CONDENSATEUR *CAPACITOR*			
C1	37 001800	15 µF +50 -10 % 16 V	RTC 122
DIODES *DIODES*			
CR1 à CR44 *CR1 through CR44*	45 003100	1 N 4448	SESCOSEM
CIRCUITS INTEGRES *INTEGRATED CIRCUITS*			
SN1 SN2 à SN8 *SN2 through SN8*	41 507426 41 640097	74 LS 26 40097	TEXAS RTC
CONNECTEURS *CONNECTORS*			
	14 170163 14 350046	TM 17 MCIG TM 35 MCIG	TRELEC TRELEC
NATTES *BRAIDS*			
	02 067300 02 067400	26 broches *26 pins* 40 broches *40 pins*	ADRET ADRET

PANNEAU AVANT / PANNEAU ARRIERE

FRONT PANEL / REAR PANEL

DESIGNATION	REFERENCE ADRET	DESCRIPTION	REFERENCE FABRICANT MANUFACTURER REFERENCE
		PANNEAU AVANT *FRONT PANEL*	
DS1	40 000600	*green* LED verte	H.P. 5082 - 4955
DS2	40 000700	*yellow* LED jaune	H.P. 5082 - 4555
DS3	40 000100	*red* LED rouge	H.P. 5082 - 4855
DS4	40 000700	*yellow* LED jaune	H.P. 5082 - 4555
CADRAN *DIAL*	81 067011		ADRET
LAMPE CADRAN *DIAL LAMP*	17 000200	6 V 0,1 A	MAZDA
J1	14 002158	BNC R 141 - 559	RADIALL
J2	14 002172	C 42334A - 176A	SIEMENS
J3	14 002005	BNC R 141 - 557	RADIALL
K2 - K4	02 700100		ADRET
K3	15 203122	3 touches *3 keys*	OREOR
K5	15 204123	4 touches *4 keys*	OREOR
K1 - K6 - K7	15 205124	5 touches *5 keys*	OREOR
P1	21 225005	4,7 kΩ/10 kΩ	MATERA CP 12
	65 005800	bouton 21 mm *knob*	ELMA 50 - 4441
	65 005900	bouton 10 mm *knob*	ELMA 50 - 2341
		PANNEAU ARRIERE *REAR PANEL*	
J4	14 002005	BNC R 141 - 557	RADIALL
J5	14 002005	BNC R 141 - 557	RADIALL
J6	14 002005	BNC R 141 - 557	RADIALL
J7	14 002005	BNC R 141 - 557	RADIALL
J8	14 002005	BNC R 141 - 557	RADIALL
K8	15 302084	inverseur *switch*	CHAUME 254 - DBO
K9	15 302020	inverseur *switch*	CHAUME 254 - DB65
K10 - K11	15 302145	TS2	JEANRENAUD
F1	17 100039	porte-fusible *fuse-holder*	ARNOULD FER 311603
S01	14 050009	connecteur DIN *connector*	PERENTA P 15 F
S02	17 003400	filtre secteur *line filter*	EUROPAVIA
S03	14 250179	25 broches *25 pins*	ANSLEY 609 - 25 S
S04	14 370180	37 broches *37 pins*	ANSLEY 609 - 37 S
S05	14 240184	24 broches *24 pins*	AMPHENOL 57 - 2024

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